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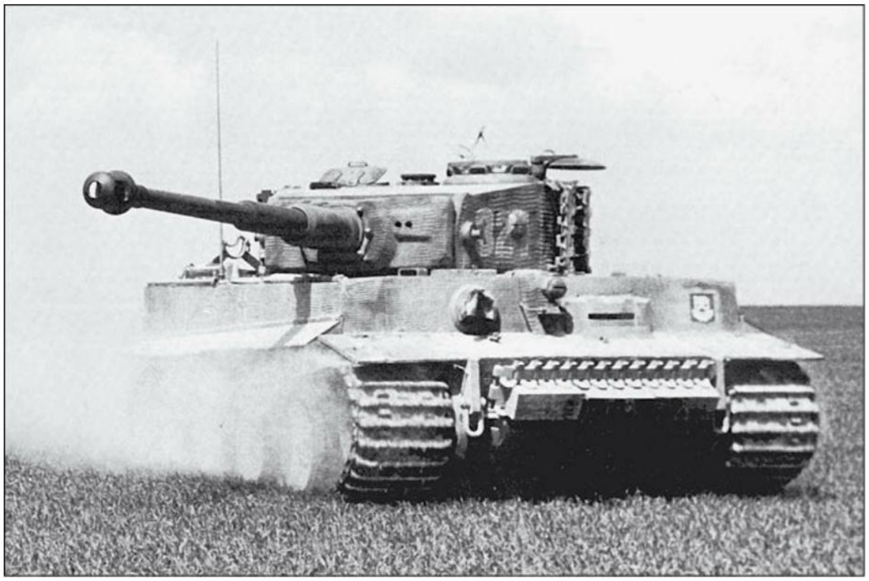

The Panzerkampfwagen *Tiger* I. (Photo: Bundesarchiv)

The use of radiators located outside the watertight part of the hull (i.e. outside the power cell) has a number of advantages on *Tiger* and *Panther* tanks and is worth considering when developing new vehicles.

Fully automatic manual transmissions and [hydrokinetic] torque converters were under development, which German engineers considered promising.

Hydraulic control circuits for transferring the power to the individual tracks by means of hydraulic pumps were built and tested [so-called hydrostatic slewing gears, which allow curves of any radius to be driven without having to interrupt the kinematic connection with the engine - ed.
author]. The results were rated as very satisfactory.

The undercarriage

All modern vehicles use large diameter wheels.

The overlapping wheel suspension used on the *Panther* and *Tiger I* tanks and half-tracks caused many problems due to the added drag when the wheels got stuck in mud or iced up. It

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the need was recognized to develop chassis in which friction of the wheels would be excluded from the outset.

Wheels with rubber coatings, which in turn were surrounded by steel rings, were judged very positively. The latter protected the rubber layer and at the same time significantly extended the life of the wheels.

Bakelite and other composite materials used for suspension authors] have proven themselves in many applications and require further research.

The use of suspensions based on torsion waves has not been widespread in recent years [the principle of operation is based on the fact that a torsion wave acts as a shock absorber, ie a spring in the form of a twisted rod. This torsional wave runs through the hull near the ground. It is firmly connected to the vehicle side wall on one side and leads outwards on the other side through a bearing, where it ends with a rocker arm, at the end of which is the wheel. This solution is currently used as standard, but is slowly being replaced by hydropneumatic suspension (as in modern buses) - ed. author]. The Germans wanted to design a cheap suspension that would not take up space inside the hull.

The tower

The design of the turret for the Panzerkampfwagen *Tiger II* was considered outstanding compared to all other types; The turret of the Panzerkampfwagen *Panther* was redesigned according to the same criteria . […]

Stabilizers for sights and guns were under development. [They enabled effective firing while driving - ed. author]. […]

miscellaneous

In the case of the *Tiger II* armored personnel carrier, all devices, including the cannon suspension, were only attached to the floor or ceiling. This practice seems worth emulating.

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In preparation were tanks for overcoming water obstacles with a depth of 6 meters. However, this project was not implemented as it was not urgent enough to justify additional costs and laborious preparations."

The development of armored vehicles proceeded in four directions simultaneously: 1. Tanks already in production were modernized. This mainly affected the Pz. Kpfw. V *Panther* and the Pz. Kpfw. VI *Tigers.*

2. Concepts of super heavy tanks were reviewed (prototypes of the Panzerkampfwagen *Maus* and Panzer *Ratte).*
3. Tanks were designed that followed the previous line of development should continue: the Pz. Kpfw. IX and the Pz.Kpfw. X [57]
4. "E" series vehicle prototypes were built - it was an alternative to the series mentioned in point 3. [58]

One might think that the most advanced designs would be at points 3 and 4, but that wasn't quite the case. For example, it was planned to significantly modernize the *Panther* tank - in such a way that in reality it would have been almost on a par with its eventual successors (E-50, Pz. Kpfw. IX).
It was planned to modify the armor, to introduce a system for efficient firing at night and while moving (gun stabilizer), to replace the classic petrol engine with a completely new generation engine with almost 50% more power (maneuverability was the weakest point of tanks from that time) and to equip the *Panther* with an entirely new drive transmission system and innovative slewing gear. Contrary to all appearances, this work was already very advanced and it was not far off until the plans were fully implemented. The main obstacle was the collapse of the economy caused by the air raids around the turn of the year 1944/45, and not the technical implementation. One of the few elements that would remain unchanged was the cannon. Despite the smaller caliber (e.g. compared to the *Tiger tank) ,* it was considered sufficient for a vehicle of this weight class

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held. In this regard, the *Panther* did not even have to hide from the heavy Russian tank IS-2 (Josef Stalin). I quote excerpts from an article on this topic, written by a connoisseur of Russian armored vehicles. The article is about the IS-2 tank:

59

“Paradoxically, the armament was the tank's greatest weakness. One of the demands placed on the vehicle designers was an armament system that would make it possible to combat all currently used and future tanks of the enemy.

As we know from articles in *Nowa Technika Wojskowa,* issues 2 and 3/01, many types of guns were tested with the IS, but preference was given to the 122mm D-25 gun from the start. In fact, it was distinguished by significantly better parameters in terms of penetration than the 76mm and 85mm guns available at the time, but compared to the enemy guns it was by no means a revelation.

It should be remembered that the D-25 had the same ballistics as the A 19 hull gun, which was primarily intended to engage targets with indirect fire, since the initial projectile velocity did not play a particularly important role when firing at fortifications.

The Panzerkampfwagen *Tiger II / Königstiger* in a version with a Porsche turret. (Photo: Tank Museum)

The situation is quite different when fighting armored targets.

Here the initial velocity has a decisive influence on the kinetic energy of the projectile hitting the target.
Therefore, a 25 kg anti-tank projectile fired from a D-25 gun with a muzzle velocity of 781 m/s has comparable armor penetration performance to a 4.75 kg slug fired with an initial velocity of 1,120 m/s. s was fired from a *75mm Panther* gun , not to mention the 88mm *Königstiger* or *Jagdpanther gun .* The capabilities of the IS-2 gun weren't all that fantastic: at typical distances at which tank battles were fought (i.e. up to a maximum of 1,000 m), fully penetrating a *Panther* 's hull front plate was unrealistic. However, I do not deny that even without penetration, a hit with a 25 kg shell (including a fragmentation shell) knocked out the tank, and especially its crew, for a while. The situation changed with the introduction of HEAT anti-tank shells, but this only happened after the war. […]

Another area related to the IS tank's armament is the ammo supply and rate of fire. The stock was only 28 pieces, ie almost three times less than the *Panther* and the *King Tiger* ! In addition, the ammunition was not integrated, resulting in the gun being loaded in two cycles. Incidentally, this was unavoidable, since a complete bullet weighed over 40 kg. This, in turn, limited the rate of fire to two to three shots per minute, while the corresponding figure for German tanks whose guns were loaded with integrated ammunition was two to three times higher. On the battlefield, something like this cannot be overestimated. Taking into account that at a distance of 1,000 m and less the IS tank did not offer protection against 88 mm KwK 43, 75 mm KwK 44 or PaK 40 shells, this led to a situation , in which the opponent had the tactical superiority.”

However, all this does not mean that the firepower of the *Panther* and

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other already manufactured tanks should remain at the same level.
As per the intelligence analysis cited above, work was being done on tank gun stabilizers. In small numbers, the tanks mentioned were also equipped with so-called "active" night sights (night telescopes) that worked in the infrared band. Of the dozens of devices developed during the Third Reich, only two were intended for tanks.

Both the FG 12/50 and the FG 12/52 were initially only mounted on armored personnel carriers (with this equipment they were given the code name *Falke), but* shortly afterwards a modification intended for the Panzerkampfwagen *Panther* was created, which was code named *Puma .* The aiming device previously mounted on 7.92mm caliber machine guns has been adapted to the 75mm tank gun. A small number of these systems were used in combat - with very good effect, which was certainly also due to the element of surprise.
Despite this, this equipment had many opponents in the Wehrmacht, probably for purely irrational reasons.

The first sharp exchange of views took place in August 1944 during one of the staff meetings of the High Command of the Army (OKH), when the future counter-offensive in the Ardennes was being planned. Based on the first clashes on the western front, most generals came to the conclusion that armored units could only operate successfully at night - provided, of course, that they were equipped with the appropriate sighting and observation devices. It was mainly about the devices FG 12/50 and FG 12/52. The facts were shocking: in July of this year, the Allied air forces destroyed around 400 German tanks within just one week (July 23 - 31). Therefore, not only night vision systems were prepared, but even special camouflage uniforms for the infrared range (which ultimately turned out to be superfluous, since the enemy did not have the appropriate sights).
These measures were undoubtedly very appropriate, potentially they represented a classic example of gaining superiority through a surprising use of new ordnance at the right time - the Ardennes counter-offensive was supposed to take place in winter, when observation conditions were best at night.

One of the senior officers of the

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However, to the surprise of those present, the General Staff stated: 63

"Gentlemen, I cannot understand what you are really talking about with this modern stuff, the front is satisfied with our measures so far".

Panzerkampfwagen *Panther,* a medium-sized tank. (Photo: Federal Archives)

As a result, some generals left the briefing room, and the expensive night vision devices that had already been fitted to the vehicles were dismantled and stored in a disused mine in Austria. Only a symbolic number remained, which could not have any decisive influence on the situation. As I have already noted, the information available indicates that this equipment saw combat use only once in the west - and that was not until April 9, 1945: in the battles at Wietersheim an der Weser, when a few *Panthers* decimated a group of British tanks, defending a bridgehead. The new invention was no longer able to reverse the course of the war US intelligence material shows that this invention was used on a somewhat larger scale and together with the Uhu system described later on the Eastern Front. It is unknown how many *Panthers* were modernized in this way, probably a company or two.

The results of their combat actions exceeded the wildest expectations, among other things, 67 "blind" Russian tanks were destroyed within just one night. 64

It is therefore not difficult to imagine what would have happened if, according to the original plan, not just a few companies, but two to three

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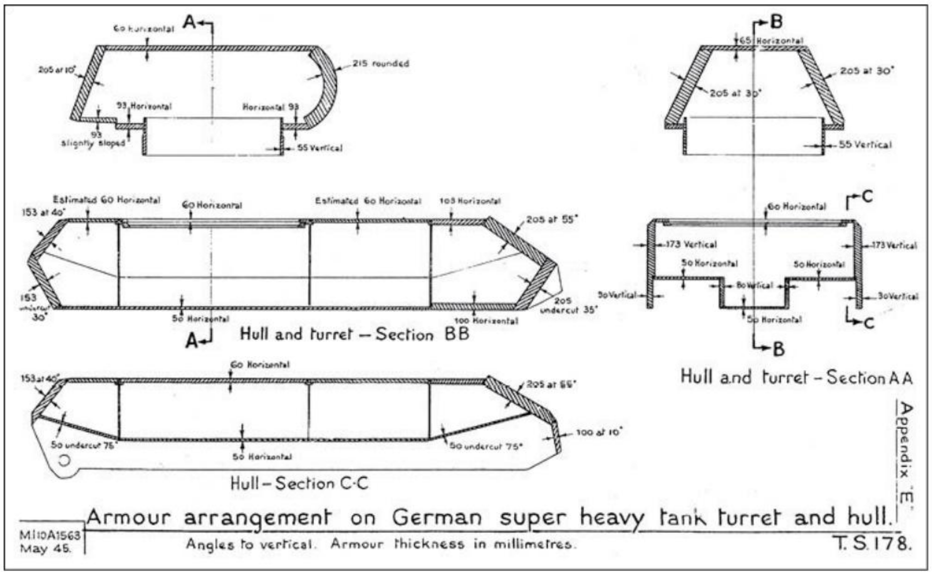
Divisions would have been converted. The course of the Russian January offensive, for example, would then no longer have been so inevitable.



Cross sections of the Panzerkampfwagen *Maus.* (Drawing from the author's collection)

One of the lesser-known areas associated with the development of armored vehicles in the Third Reich concerns the vast (though seemingly unintriguing) issue of hydraulic drive-transmission systems. This is both a type of hydrokinetic clutch (non-rigid connection) that transmits torque from the engine to the manual gearbox, as well as similar devices that guarantee a smooth change in the turning radius with almost no loss of power from the power unit, unlike the previous ones Solutions in which the driver switched off the drive of one of the tracks in order to be able to drive around corners. On the one hand, the goal was to minimize power losses: If the kinematic connection to the engine is not interrupted when changing gears, e.g.

B. the vehicle acceleration considerably. On the other hand, it was simply the result of searching for the most reasonable way to replace the classic clutch, which has limited durability and cannot work under arbitrarily large loads - in locomotives, e.g. B. there is usually no rigid coupling, because by switching on at high engine speed they simply burn, and the train does not

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would drive off. With the hydrokinetic counterparts, on the other hand, the problem of friction does not arise because there is no rigid contact surface. The simplest variant of such a torque converter is a type of double turbine. In a hermetic, almost cylindrical case filled with oil, there are two rotors equipped with respective blade rings (which are not connected to each other, although they are on one axis). When one of these begins to rotate, it sets the fluid in motion, which in turn forces the second rotor to move. Contrary to expectations, the losses are not particularly high and – except at low engine speeds – no greater than two to four percent.

The *Maus* tank at the end of 1944 at the military training area in Kummersdorf. (photo from the author's collection)

The *mouse* in profile. (photo from the author's collection)

Such devices were not a German invention - the Americans and British were already working on them before the war. However, the German company Voith from Heidenheim was the first to start developing a whole series of models intended for combat vehicles.

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Hydrokinetic should be used in the Panzerkampfwagen drive transmission system in *Panther, Tiger II / Königstiger* (in both versions) and the E-25. This work was not completed - it was interrupted by an administrative decision of August 8, 1944. However, if we take into account that at the same time work was being done on an electric drive transmission (alternator - electric motor, as in the case of the self-propelled cannon *Ferdinand / Elefant* and the super-heavy tank *Maus) ,* hydrostatic slewing gears were developed and also planned, which at the time were relatively modern diesel engines use, it is more reminiscent of the 1970s.

By the time of World War II, however, the only Voith-manufactured hydrokinetic propulsion system that was in widespread use remained a solution intended for locomotives capable of power transmissions of up to 1,800 hp. 56.60 In addition to the hydrokinetic and electrical system for power transmission, another alternative emerged that allowed the increasing engine power to be better exploited. It was an automatic transmission with magnetic (electromagnetic) clutches, developed under the designation G/EV/75 by the company ZF (Zahnradfabrik in Friedrichshafen) - a six-speed transmission. Its application was considered on the new Panther versions, while modified versions were to be installed on the E-10 and E-25 vehicles. 62 The engines themselves were petrol engines in all tanks used in combat; in the near future they should be replaced by diesel engines.

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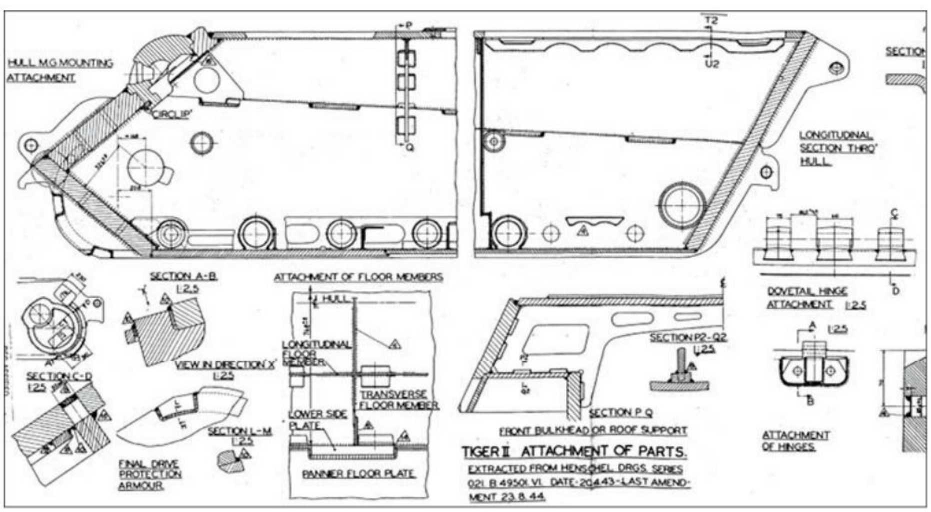
Unfinished fuselage of the E-100 on a special transport trolley. (Photo: NARA)

At the same time, the companies Daimler-Benz, BMW and Heinkel Hirth took a completely different approach: they were already working on the successor generation of diesel engines, namely turbine drives. This step, combined with other measures, would have led to a true revolution on the tank battlefield. It was e.g. For example, an engine with an output of 1,000 hp was developed, whose turbine (!) had a diameter of just 32 cm. The Panzerkampfwagen *Königstiger* (Pz. Kpfw. VI), for example, was to be equipped with such a drive system, designated GT-102 . 61 The Germans managed to overcome some fundamental problems – including the manufacture of “hollow” turbine blades for cooling and effective ceramic protective linings for these blades, which increased their lifespan by about tenfold.



Cross sections of the *Tiger* II fuselage. (Drawing: CIOS)

The only downside of such an engine is the average double

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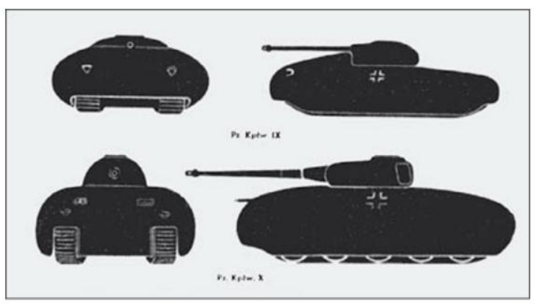
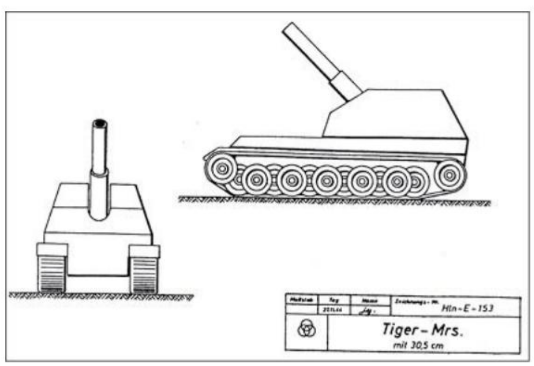
such high fuel consumption compared to the classic counterpart, but the superiority over the petrol-powered piston engines used at the time was colossal. What was particularly noticeable was a significant increase in performance with a simultaneous reduction in engine weight and overall engine volume. Added to this was the elimination of the cooler and the avoidance of vibrations - and the latter affected the aiming.
This eliminated the main disadvantages of World War II tanks, which made it seem impossible to reconcile three basic characteristics: firepower, armor and manoeuvrability. With the exception of light tanks, the last characteristic was usually sacrificed - the Tiger tank, for example, powered by a 600-700 hp engine (depending on the version) had a top speed of only 30-40 km/h.



Vehicle concepts Pz. Kpfw. IV and Pz.Kpfw. X. (photo from the author's collection)



Project of 305mm self-propelled mortar on Tiger tank hull.

At the end of the 1960s, the “revolutionary” German-American Kpz-70 / MBT-70 tank (which did not go into mass production) was introduced to a small circle of military officials.

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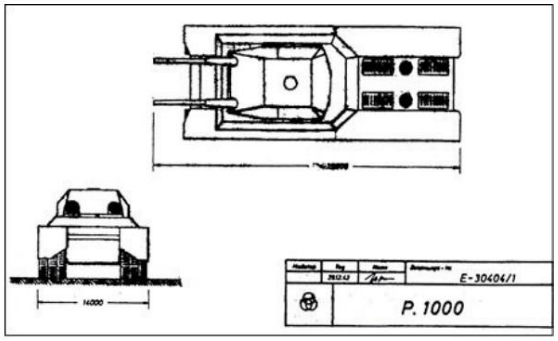
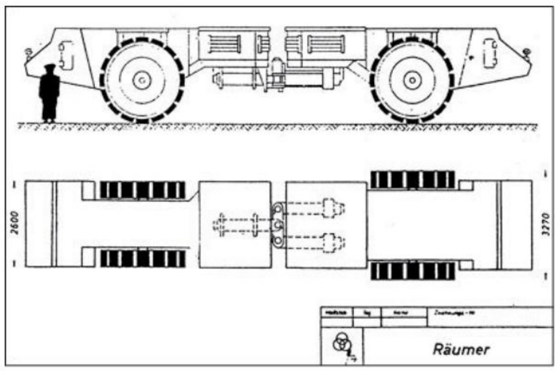


The Rat Tank Project.



Der *Räumer-S.* (original drawing)

This "super tank", which incidentally was half developed by the Krauss-Maffei factories that dominated during the war, was equipped with, among other things, a stabilized large-caliber cannon, a turbine drive, a hydrokinetic system for power transmission, hydrostatic rotation mechanisms and a protection system equipped with weapons of mass destruction. All this made an entirely new impression - but in fact this technology was already a quarter of a century old, and this case was not the only one.

At the same time as the modernization of existing vehicles, further concepts developed:

Two new types (Pz. Kpfw. IX and Pz. Kpfw. X) were in development, intended to succeed the *Panther* and *Tiger* .

They should feature fully cast hulls and turrets in the form of monolithic elements. Very little is known about them other than tentative plans. 57

A whole series of “E” series combat vehicles was developed, also

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the so-called super-heavy tanks *Maus* and *Rate* - enlarged development versions of the *Tiger* and the E-100.

The "E" series is a new generation of combat vehicles, consisting of five types: 58 1) the light E-10 weighing 10-15 tons; 2) the E-25 vehicle weighing 25-30 tons, similar to that

Jagdpanzer 38(t) *Hetzer;*

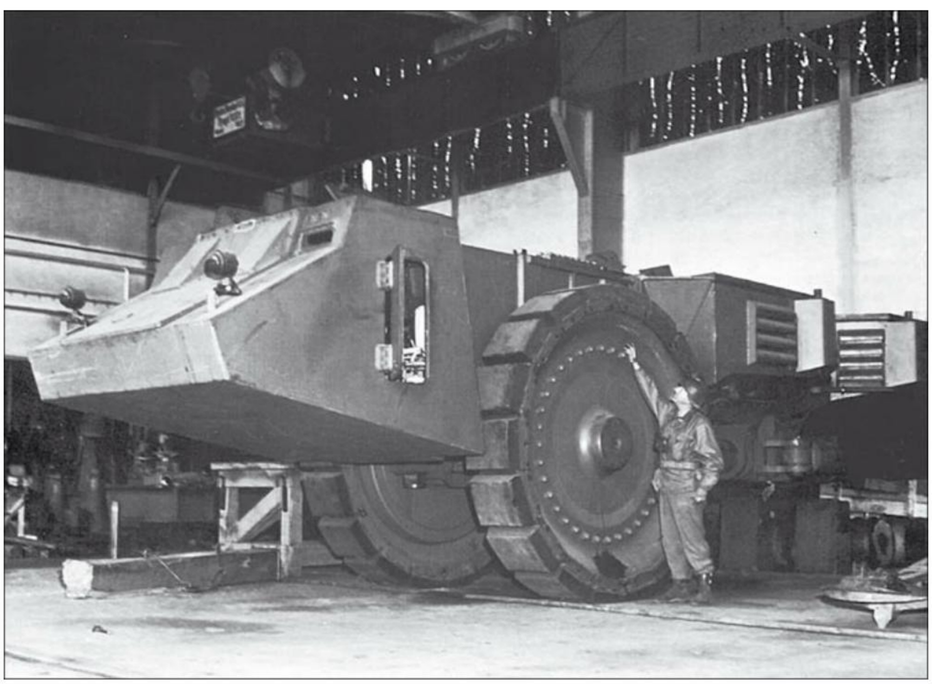
3) the E-50 tank weighing about 50 tons, which was supposed to replace the *Panther ;*

4) the E-75 tank - the successor to the *Tiger.* This would have been the first mass-produced Panzerkampfwagen with hydromechanical drive transmission;

5) the E-100 super-heavy tank with a weight of 130-140

Metric tons.

Although the latter was the least useful from a military point of view, its development was the most advanced.



The *Räumer-S* fell into the hands of the Americans. (Photo: NARA)

Shortly before the completion of the first prototype, production began

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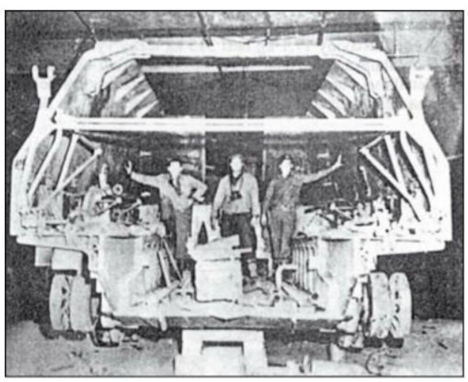
of the E-100. In 1943 it was planned to produce the remaining models around the turn of the year 1944/1945. The E-100, christened the *Adler* , was 40 tons lighter than the *Maus,* despite using almost exactly the same turret and similarly strong frontal armor, and the fuselage, although slightly lower, was actually wider - and that despite the heavy armament! The main reason was to move the heavy armor forward. Undoubtedly its greatest strength was its armament, which was intended to be even heavier than the *Maus* ' 150mm cannon (although its usefulness in real combat can be questioned). The drive, on the other hand, was rather backward - the engine from the half as heavy and still not particularly mobile *King Tiger* with an output of 700 hp would have only allowed a speed of a good 20 km/h on the road. In June 1944, Hitler personally gave the order to stop the assembly work on the *Adler* prototype , although it was being carried out at a very slow pace (the Henschel company, where assembly was carried out, assigned this task to only three people; moreover, parts were also missing) until were continued until January 1945. The direct competitor of the E-100 was the super tank *Maus* with a combat mass of almost 200 tons, ten samples of which were in various stages of construction. The *Maus* was probably the most curious combat vehicle of World War II.



The unfinished prototype of a 170mm self-propelled gun mounted on the enlarged *Tiger* II tank hull. (Photo: NARA)

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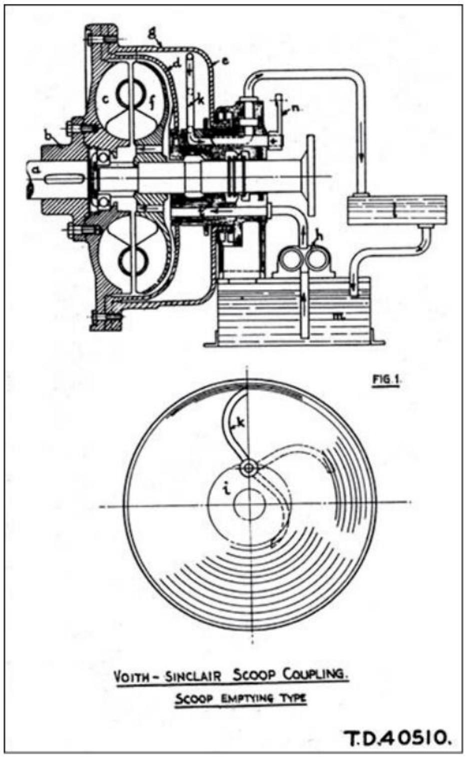

Cross-section of the Voith company's hydrokinetic propulsion transmission system designed for tanks during the war. (Photo: CIOS)

The vehicle was designed by Professor Ferdinand Porsche. The decision to start designing this unusual construction was made on November 29, 1941 by Hitler (who was known to have succumbed to gigantomania – it wasn't his last word on the subject either), right after an "inspiring" conversation with the professor. As early as June 1942 he presented Hitler with the first plans for the vehicle - at this point the question of possible armament was also discussed. Two variants were considered - both of which would have two guns mounted in the turret: a 75mm gun and a 150mm gun, or a long-barreled 105mm gun (the barrel was to be around 7.5m long).). In the end, however, the decision fell on a medium-sized solution: the 128 mm KwK 44 L/55 gun, which became the vehicle's basic armament. The contractors were also selected: the Krupp works were to manufacture the towers and hulls, the Siemens-Schuckert company to build the electrical equipment, the Skoda company to carry out the suspension and the Berlin company Altmärkische to assemble the finished vehicles

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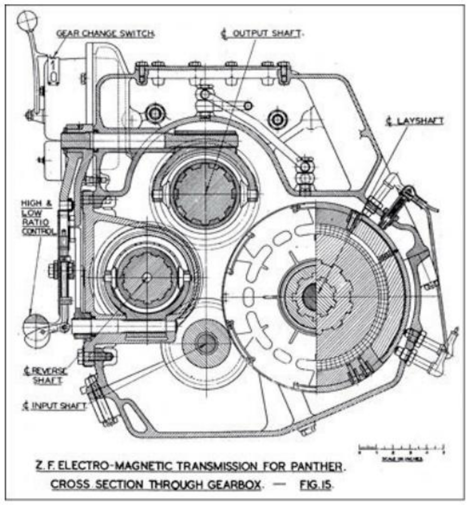
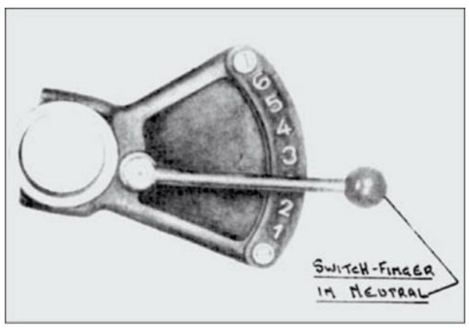
Chain factory commissioned.



Cross-section of the electromagnetic propulsion transmission system for the *Panther tank.* (Photo: BIOS)



A fragment of the electromagnetic drive transmission system for the *Panther* tank - the gear change switch. (Photo: BIOS)

It should be noted that neither the *Maus* nor the rest of the super-heavy tanks were intended to represent classic "breakthrough vehicles", although their construction and general appearance did not differ from the construction of typical tanks. Due to the expected low maneuverability (which was evident both from the parameters of traction itself, and from fuel consumption, the ability to negotiate terrain, as well as the use of bridges and roads), they simply were not able to perform the tasks intended for “ordinary” tanks . Rather than forming typical battle formations, they should serve as mobile fortification lines that are constantly changing

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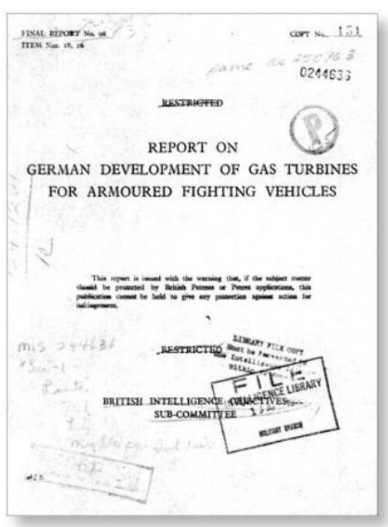
move and how heavily armed and armored bunkers could be moved. In a sense, this represented an attempt to hark back to World War I positional strategy, similar to the case of the gigantic and expensive but ineffective rail guns. Ultimately, the attempt was probably just an expression of certain preferences and personal weaknesses.

Incidentally, the mistake made here was to reduce its purely defensive capabilities - in its first version, the *Maus* was not equipped with a single machine gun!

Nevertheless, a number of original and interesting solutions were used on this tank, among the most important of which was certainly the propulsion system, which was based on an electromechanical system: power was not transmitted directly from the engine to the wheels, i.e. through gearboxes and clutches, which propelled the caterpillar tracks, but transmitted by an electric generator and two lateral electric motors. This was not an entirely new solution: as early as 1940, Porsche designed an electromechanical drive system for the VK 3001(P) tank prototype, which did not go into production because it was inferior to the *Tiger .* After a redesign, however, it became the self-propelled cannon *Elefant,* better known under the unofficial name *Ferdinand,* which was included in the arsenal in a limited number (88 pieces). It was the first vehicle with such a drive transmission to be used in combat.



FINAL REPORT No. 96
ITEM Nos. 18, 26

COPY No. 151

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REPORT ON
GERMAN DEVELOPMENT OF GAS TURBINES
FOR ARMOURED FIGHTING VEHICLES

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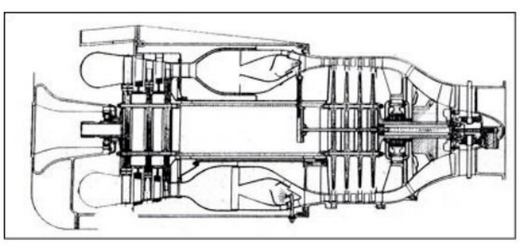
Cover page of the report mentioned in the text.

The construction of the Maus tank, including the preparations for its production, devoured huge resources and was associated with major problems that were disproportionate to the real combat value. These problems arose from the unusual size of the vehicle and the dimensions of its armament - the almost one meter long recoil of the main gun and projectiles 1.52 meters long required a huge turret weighing more than 50 tons and with the weight of the *Tiger* Panzers was comparable.

The main gun alone weighed seven tons. The turret accommodated four crew members - the tank commander, the gunner and two loaders. Incidentally, they had to carry out particularly "heavy" tasks, since the (integrated) projectile for a 128 mm gun weighed around 56 kg.

It was one of the most heavily armored combat vehicles - the frontal part of the hull was made of 205 mm thick armor plates with a slope of 35° and 55°, and the frontal part of the turret was a profiled plate with a thickness of 215 mm. The rest of the armor was also more than 150mm thick and exceptionally resistant to penetration (which best illustrates the vehicle's role as a "mobile bunker"). Only the tower ceiling was designed as a 65 mm plate.

A very interesting side effect of the electromechanical propulsion system was the way the craft coped with water hazards. The *mouse* was able to overcome it to a depth of 6 meters, i.e. at full draft (provided, of course, that it did not bury itself in the swampy ground). All that would have been needed was a second tank of this type with the engine switched on, from which the cables would run to supply the electric motors.



Selected types of German turbine engines for tanks. (Photo: BIOS)

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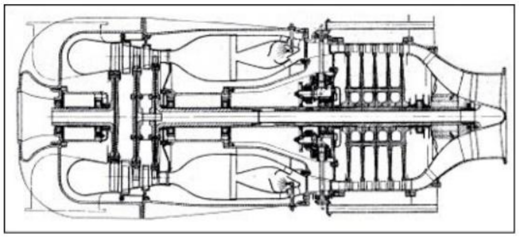

The first examples of this tank were ordered in mid-1942 and the first batch of 180 units in March 1943. But although the construction program was given the highest priority and was enthusiastically supported by Hitler, in practice it was far from the plans: in addition to construction difficulties, the air raids also contributed to this. The first prototype was not ready until late 1943, although it was still incomplete - the turret was missing. The second and only complete prototype was not delivered until November 1944. Before the end of the war, a few more were in various stages of assembly. The *mouse* remained just a curiosity

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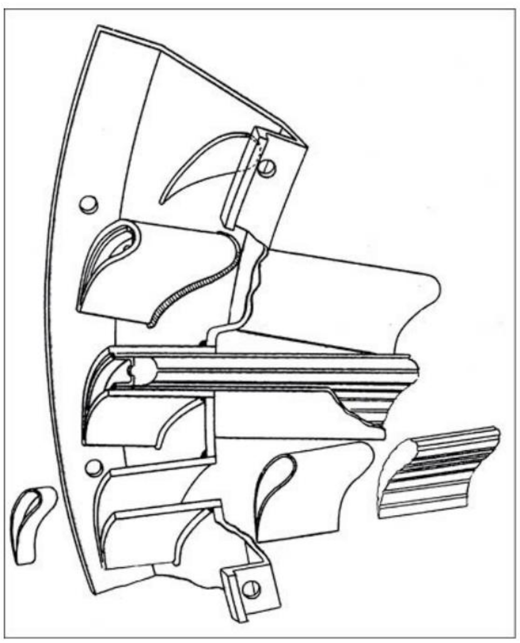

Part of one of the engines - method of making blades. (Photo: BIOS)

However, the gigantic *Maus* and *Adler* tanks, which were not particularly useful from a military point of view , were not the culmination of Hitler's aspirations in terms of armored vehicles. They were truly miniature compared to a tank weighing 1,000 tons, with their design

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he instructed the two engineers Grote and Haker on June 23, 1942 during one of the meetings devoted to the future of tank manufacture. This "super giant", which was quickly given the name *rat* (similarly teasingly as in the case of the *mouse) ,* was to have a classic design, apart from the turret armament, which was to consist of two (identical) large-caliber cannons (around 200 mm). At approximately 100 feet long and nearly 30 feet tall, the *Rat* would be something of a "land cruiser," but let's not be fooled - the design problems associated with its eventual construction were utterly insurmountable for the German wartime economy. Hitler's idea was almost a collision of utopia and reality, so work on this tank was interrupted before the design phase was completed.

However, among the German achievements were a number of much more meaningful innovations in the field of armored vehicles. For example, the introduction of HEAT anti-tank shells and rocket shells into the tank armament (including the very passable 45/55 mm cone-barreled cannon mounted on the Pz. Kpfw. IV vehicles) should be mentioned here.

A similarly ground-breaking step was the introduction of uranium-core slugs into production, intended to use hundreds of tons of uranium that was superfluous to the delay-plagued nuclear weapons program.

Also noteworthy are the little-known achievements of the Third Reich in the field of artillery armament.

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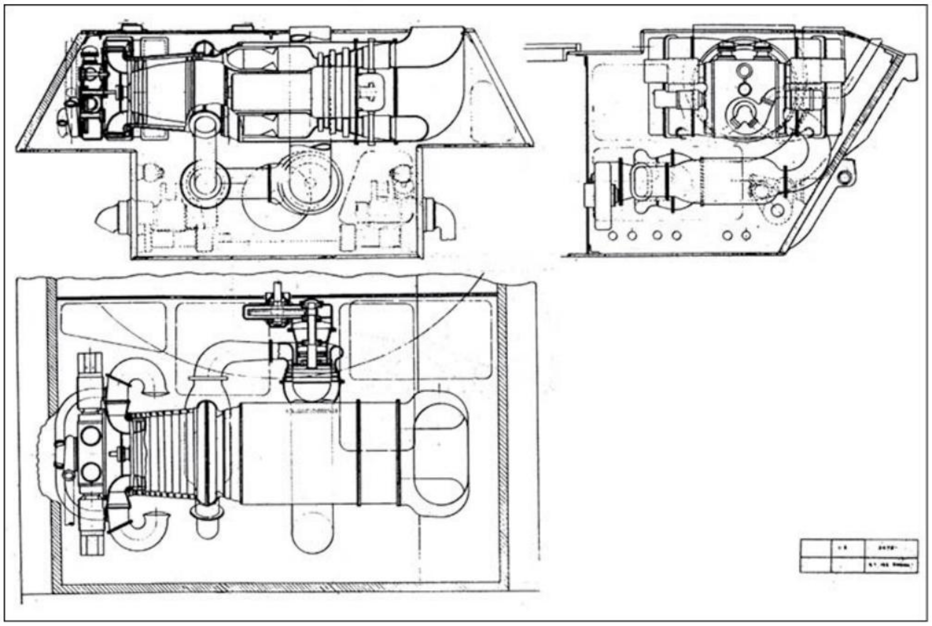

Installation position of the GT-102 turbine engine in the fuselage of the *King Tiger.* (BIOS)

In addition to the development of rail guns as huge as the "super tanks", a number of groundbreaking fin-stabilized, jettisonable jacketed rockets were also designed (mainly at Peenemünde) for use in some new smoothbore guns - initially primarily for the long-range multi-chamber gun V3, the famous *centipede* – were intended. However, a new 800 mm gun (!) was also in the design phase, for which a technically particularly advanced projectile was designed. This gun, weighing approximately 1,500 tons, was to be mounted on a modified Ratte tank hull. The hull of the *Tiger* II tank was intended to serve as a base for a self-propelled gun, this time of 170 mm caliber. The prototype of this gun was built during 1945 - it received the marking 17 cm K44 Sf/Gw-IV. It was also planned to install a 210 mm and a 305 mm mortar *(Bear)* on the same chassis . 65

So as you can see, the *Maus* was n't the only "super heavy" vehicle weighing over 100 tons. There was even another one, although it wasn't a tank but a demining vehicle.
Apart from the weight itself (130 t), its construction was also very unconventional. The vehicle consisted of two hulls connected by a

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joint were connected. Each hull had only one pair of wheels, but the wheels had a diameter of almost three meters. The wheels were made of steel and equipped with very thick rubber coatings, impervious to exploding mines. But there were only a few prototypes of the *Räumer-S* .

Cross sections of the Panzerkampfwagen *Maus.* (Drawing from the author's collection)

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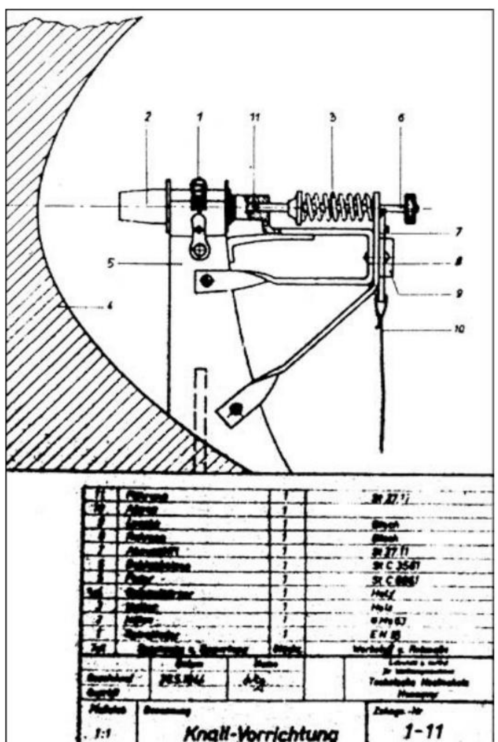
Conventional weapons: entirely new concepts

This chapter is by no means devoted to all of the innovative concepts in the field of conventional weapons that were introduced or simply subjected to scrutiny during the Third Reich, but only to the most interesting and least known ones.

energy emitter

Let's start with the really unusual inventions - the "sonic cannon" and the "wind cannon", a directed air shock wave generator. 65



Original technical drawing of the "Schallkanone".

The sound cannon was the incomparably simpler construction: a

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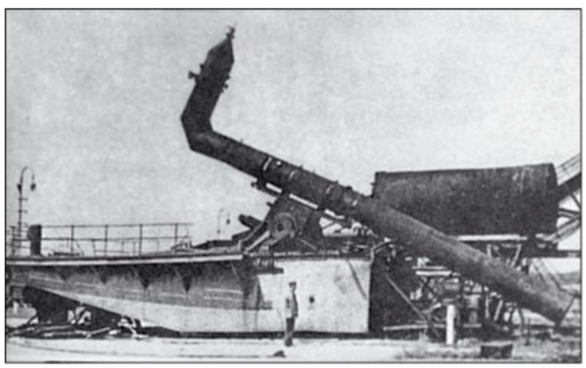
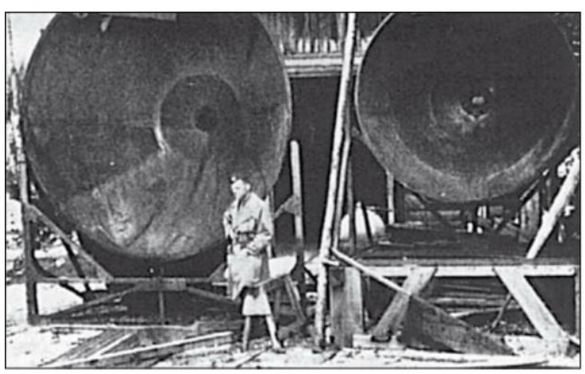
large, massive parabolic mirror with a diameter of 2.3 meters, at the focal point of which a small explosive charge was detonated (it is known that, among other things, nitroglycerin charges weighing 19 kg were used). A little later they decided on a mixture of methane and oxygen, which was detonated in a chamber placed on the axis of the paraboloid, with the paraboloid being a quarter as long as the sound wave produced. The advantage of such a solution was to achieve a high rate of explosion (800 or 1,500 explosions per second), as well as in the long-term operation of the device. Its effect on humans was mainly based on the stupor and paralysis of the nervous system (it was found that the affected person perceived, among other things, point sources of light as lines). The work was carried out in a research facility under the Speer Ministry near Lofer in Austria.



An experimental directed air shock wave generator. (Photo: NARA)



Two models of the "sonic cannon" for generating a directed shock wave. (Photo: NARA)

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dr Richard Wallauscheck was responsible for them. The mode of operation of this invention was based on the fact that a shock wave behaves like any other plane wave, ie it can be focused at one point, it is subject to interference, wave diffraction and the like. – in short: it is completely predictable from the geometric point of view. It should be remembered that a shock wave is the most effective energy source outside of nuclear physics. In contrast to the sound wave, the jump in density at the shock wave front is completely instantaneous (non-linear), and in the case of strong explosives this pressure change can be millions of times, resulting in a very high density of destructive energy.

This "cannon", with an effective range of several hundred meters, was intended - and probably was - used against humans, but never in combat. A “light cannon” was supposed to be based on a similar principle, but it was probably never completed.

A further development of the "sonic cannon" was a tube device that produced a powerful, relatively directional shock wave of air. It was developed by a Stuttgart company and tested at the test site in Hillersleben. As the American intelligence service found out, it was able to penetrate a 25 mm thick steel board at a distance of 200 meters, but the effectiveness decreased very quickly with increasing distance. For this reason, the planned use of the prototype for anti-aircraft defense to defend a bridge over the Elbe was abandoned at the end of the war. However, not all areas of the scientific-technical search turned out to be dead ends after the war.

"Invisible" planes and ships

Some of them were the beginning of promising or even pioneering currents in weapon technology, although they have remained practically unknown to this day. A perfect example of this is the German research program to develop materials that improve detection by radar, echo sounders and the like. should prevent - an area that is now described with the English term "stealth".

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Only recently have I been able to obtain the relevant sources - documents that describe these works. It is about the already mentioned work of institutes that were subordinate to the Reich Plenipotentiary for High Frequency Research (BHF).[8th] It states that the company IG Farben was primarily responsible for this work, which cooperated in this area with the Technical University of Gdaÿsk, among others. The head of the chemical laboratories at the university, Prof. Dr. clamp. Karl Roewer, a qualified engineer, was in charge of "purely radar-related" matters. It is not known exactly to which institution he belonged.

It is stated that two aliases were used for the project mentioned, at least the first of which sounds very modern: *Black Aircraft;* the second was a *chimney sweep.* Another white spot in the history of the Second World War!

Unfortunately, I will only partially succeed in filling it out.

Information on this subject was obtained through interrogations of the individuals mentioned above. American intelligence officers also found Klemm's laboratory in Schmalkalden, Thuringia, where he had worked during the final months of the war. An apparatus for the analysis of new materials and corresponding samples were discovered in Travemünde near Lübeck - pressed plates consisting of powders of an unknown composition (at the time of writing). The substances themselves were in small quantities in the laboratories of the IG Farben group in Höchst.

Basically, in this research area, the search was for materials with magnetic conductivity and electrical permeability, which should correspond as closely as possible to the properties of air. During the war, materials were studied and produced in small quantities in Travemünde, which mainly absorb waves from the medium frequency range (up to 100 kHz). Substances were in the development stage that were intended to protect against detection by radar devices that worked with higher frequencies (i.e. were of a more modern design) - shortly before the end of the war a device was completed in Travemünde with which substances could be checked for these properties.

Although these works were extremely innovative, they were never considered a priority in the Third Reich. The materials described

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were used almost exclusively for experiments. The only exception I know of is Type XXI submarines, which came standard with snorkels encased in this type of material.
The end of the war meant that interest in "stealth technology" temporarily waned. The Americans only remembered the German research in the second half of the 1950s, when they developed anti-radar paints for the SR-71 *Blackbird* supersonic reconnaissance aircraft - the first flight of which took place in 1962. This area is currently undergoing rapid development, since radar detectability is one of the most important problem areas in modern combat aircraft.

While I was already working on this book, I came across other Allied intelligence elaborations on the subject, and these reports were quite unusual. As it turned out later, there were at least four more besides those already mentioned 66,67,68,69 This of course testifies to the further such elaborations!
Significance of this complex of questions for the "conquerors". Additional information can be found occasionally in the report on the American espionage *operation Lusty,* which is described in detail in the second part of the book. It is clear from this report that the IG Farben Institute near Frankfurt (in Höchst) was not the only important institution in this field. The following were also mentioned: 1) the Gdaÿsk Institute for Inorganic Chemistry (Prof. Klemm) 2) the Osram company - "Study Society for Electrical Lighting" - Berlin (Dr. Friederich) 3) the laboratory of the Degussa concern - 8 km from Konstanz, near Lake Constance (Prof. Fuchs and others) 4) the laboratory for ceramics of the company Lutz and Co. in Lauf/Pegnitz in Bavaria (Dr. Franz Rother - inventor of the material used for submarines of the type XXI was used) 5) the Technical University of Stuttgart (Dr. Fricke) 6) the Technical University of Prague (Prof. Hüttig)

There were also other clues, such as B. the report of a Polish soldier who did his service at the former German airport Sorau (ÿary) near Zielona Góra shortly after the war. He described how one of the

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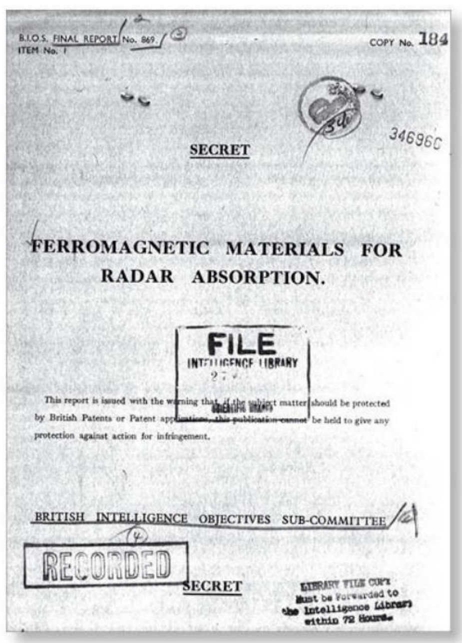
Airplanes were painted with some gray porous "quasi-paint" found in an abandoned barrel. It caused the light *stork* to become completely invisible to radar equipment.

In addition, materials were also developed in the Third Reich that were intended to protect submarines from detection with sound methods (ASDIC - echo sounder) by absorbing sound waves propagating in the water. Here, too, there are striking similarities to post-war developments, including the Polish submarine "Orzeÿ - III" ("Eagle"), which was bought by the USSR in 1986 and was equipped with an identical protective layer as some submarines at the end of the Second World War.

The IG Farben Group was also able to record groundbreaking successes in this area, above all its laboratories in Höchst on the outskirts of Frankfurt am Main.[70] The investigations began in 1940 and ended in 1944 with the launching of twelve submarines with an "anti-sound layer". This project was codenamed *Alberich.*



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FERROMAGNETIC MATERIALS FOR RADAR ABSORPTION.

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Cover pages of selected intelligence reports on German "stealth" technology.

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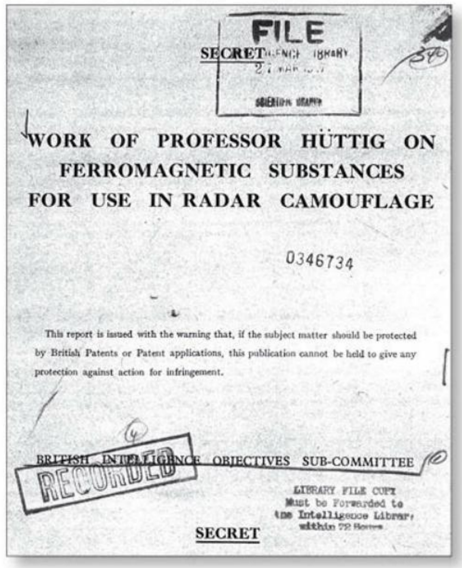
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WORK OF PROFESSOR HÜTTIG ON FERROMAGNETIC SUBSTANCES FOR USE IN RADAR CAMOUFLAGE

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Although certain preparatory work had been carried out before 1940, it was only then that a "serious" program could be said to have begun. This year is associated with the realization of a completely new concept, the originator of which was Professor Meyer from the Heinrich Hertz Institute. It was based on the use of many suitably shaped layers of specially selected rubber, where a key advantage over previous ideas was that the outer layer remained smooth - so hydrodynamic drag did not increase. It was an effective yet simple solution. Most of the variants examined can be described as follows: Two thin rubber flaps (approx. 2 mm) were glued one after the other to a steel plate, which represented an imitation of the outer skin of the fuselage. The outer layer consisted of a closed smooth flap. As expected, the most important role was played by the layer that adhered directly to the fuselage. It was perforated and fitted with a large number of smaller (up to 2mm) and a slightly smaller number of larger (about 5mm in diameter) holes in which, due to interference, much of the sound wave was supposed to be attenuated; the diameter of the holes was inversely proportional to the frequency. The whole thing therefore formed a soft, almost spongy screen intended to blur the "sound image" of the boat.

Despite its simplicity, this disguise, if properly designed, could be very effective - the maximum measured

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Degree of attenuation (for a few kHz) was 95%. However, that is only one side of the coin. Such great effectiveness could only be achieved if the hole diameter was ideally "matched" to the sound frequency used by the enemy. The Germans feared that by using devices that worked in different frequency ranges, Meyer's invention would become much less important. (By the way, this is exactly the same problem as the "stealth" coating for airplanes; e.g. the "invisible" American F-117A bombers are relatively easy to detect using old types of radars that work in the medium wave range). In the case of the “anti-sound coating” another problem arose: it was obvious that it would only be effective to a depth where the “air bubbles” would not have the same density as water due to the pressure. Calculations and measurements in a special pipe, which was set up vertically like a chimney, showed that this limit is around 70 meters deep. Nevertheless, the invention was valuable because it allowed effective protection during combat operations when the boat was at shallow depths and close to enemy units (although Type XXI boats were the first to launch an attack without using the periscope over the to push out of the water surface, they still had to maintain a shallow diving depth). At greater depths, this problem was not so precarious, mainly because a sound wave does not propagate “down” in the same way as it propagates horizontally. The sea is by no means a homogeneous mass of water, but has a certain structure and is divided into many "layers", which differ in their salinity, oxygen content, etc. award. This manifests itself in almost erratic differences in density, which in part leads to reflection, refraction and ultimately scattering of the sound wave. In the ocean (ie without the influence of the sea floor), these phenomena take place at a depth that exceeds the height of the waves (water mixing) by an order of magnitude, ie below, say, 100-200 meters. Submarines, on the other hand, reached a depth of about 300 meters. Of course, they could also be detected at this depth, but the diving depth is generally a parameter that affects their detection possibility the most. The second important parameter is, of course, the maximum speed developed under water, that is, the escap

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In spite of everything, the invention turned out to be relatively valuable and "definitely worth owning" - at least that's the conclusion reached by the American report.

The snorkel of a Type XXI submarine, covered in "Stealth" material.
(Photo from the author's collection)

The Germans equipped twelve of their submarines with the *Alberich* coating off. The majority of these were merely tested, and only two took part in combat operations. One of these was sunk, but it did not have a snorkel and was probably spotted by radar.
It was not specified what type of boat it was. When discussing this material, a neighboring, important and little-known area should not go unmentioned: the plastics of the Third Reich. Another intelligence report enables us to do so.
71

plastics

Plastics are primarily associated with the 1960s when they revolutionized industrial design and found their way into a range of everyday objects.

However, as with much of the "news" of the period, the real point was to introduce revolutionary advances in World War II science and technology to the mass market. Plastics were one of them
...

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Their appearance is often attributed to the Americans, the inventors of the nylon fiber (Du Pont concern), which was then called synthetic silk and became fashionable because of new seamless stockings, although it turned out to be the most valuable primarily as a cheap raw material for parachutes, which man could now produce in virtually any quantity.

The Germans also had nylon, and they mastered its manufacture not much later than the Americans; they also developed many new plastics—about a dozen different types in all.

We know most of them from our own experience.

Of course, the earliest to appear were chemically hardened phenolic-based plastics, such as Bakelite, which was widely used even before the war in the manufacture of handgun ancillaries – stock pads and butt flanges – and electrical insulators. Its production started in small quantities even before the First World War on the basis of a Belgian patent. On the other hand, when it comes to the work carried out in the Third Reich, the following turning points can be distinguished:

- June 1938: the first composite (high-strength fabric laminated with plastic)
- January 1939: Synthesis of the first thermoplastic polymers. At the same time, polymer bearings were being developed, production of which began in September 1939.
- January 1942: first production of elements from thermoplastic materials using the casting process, which four months later was replaced by the injection molding process
- May 1942: Development of a specification for the manufacture of Composite Rolling Bearings
- March 1943: Specification for the manufacture of plastic elements in the stamping process

During the Third Reich, the IG Farben concern was a monopolist in the development and production of composite materials, and the most important role was played by its plants and laboratories in Bitterfeld, in Höchst (near Frankfurt am Main) and in the Oppau district of Berlin, where the headquarters of the " Nitrogen Syndicate", a department of IG Farben that specialized in this field. This area took a key position

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- which was also expressed by the appointment of a special representative in the Speer Ministry, who was responsible for the realization of priority war projects of the government ("Special Representative for the Nitrogen Industry"). The Germans also commissioned a number of companies in the European countries they occupied, mainly in France, Belgium and Holland, with the realization of their ambitious tasks, including the Phillips works in Eindhoven and Venlo, the Cogebi company (Compagnie Generale Belge d'Isolants) in Loth near Brussels and the "Institute for Plastics" in Delft.

Overall, the following plastics were developed: •

polystyrene – this material was produced in small quantities under the name “Trolitul” and was considered uncompetitive; • Polyvinylcarbazole – an injection-moulded, ie technologically favorable composite material which, due to its fibrous structure, is characterized by very good load parameters and very low electrical and thermal conductivity. This substance was considered promising;

• Polyvinyl chloride - manufactured in many grades, including in Venlo, for various applications (PVC); • Plexiglas (polymethyl methacrylate) – commonly known as “organic glass”. Because of its low tendency to burst, glazing elements for aircraft were made from it. An alternative was standard vinyl laminated (glued) glass manufactured by the "Société de Verreries des St. Gobain" in Lyon. The Germans planned to produce elements for simple optical devices from Plexiglas, but ultimately only lenses for flashlights were made from it; • Polyvinyl acetate (PVAc) – a very tough substance that has been tested as a concrete additive; possibly intended to be used in concrete armor cladding;

• Polyamide (Nylon) – a material used during the war in different variants was produced;

• Polyethylene - despite intensive research, the investigations could only be completed after the war in the FRG. Polyethylene is a plastic from which plastic bags, hypodermic syringes and the like are made today.

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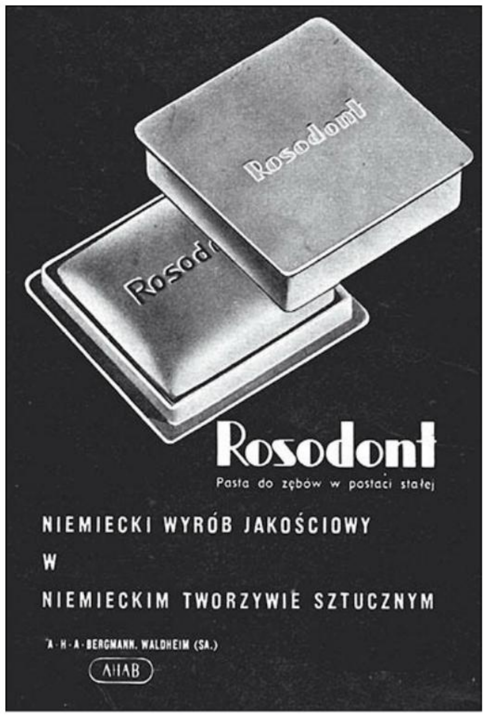
getting produced;

• Polyisobutylene – a material used as a rubber substitute during the war; • Aldols – form an alcohol group, which is a polyvinyl derivative from which

Among other things, cable insulation was produced.

In addition to the plastics mentioned above, research was also carried out into some new substances that had been discovered before the war. Various cellulosic compounds have been synthesized, including photographic film containing celluloid, a packaging sheet made of cellophane, and the



A German advertisement from 1944.

Due to their insulating properties, the Germans mainly used the plastics in the electrotechnical and electronics industry. However, it became clear that these materials were also gaining popularity in other areas – in the form of plastic containers, nylon camouflage nets, and PVC tiles and buttons. A polyamide film with high tear strength was produced in small quantities - among other things for the production of audio tapes (which were mainly used by the GESTAPO). The Germans also mastered the technology of the

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Manufacture of synthetic fabrics… this area is important if only because it initiated the industrial use of composites – e.g. B. in aviation. 71

The war under water

Another and little-known area, already hinted at in the previous pages, is technology related to the “war under water”. The problem was simply that the war at sea was fought with the help of submarines which (with certain exceptions) had been built before the war.

The results of the research conducted during the war have therefore remained practically unnoticed until now.

So it is somewhat paradoxical that despite the huge sums invested in research, the Germans began to lose the war in the Atlantic.

It didn't even help such "news" as e.g. B. an acoustically guided torpedo (the T-5 torpedo *Zaunkönig,* which was added to the arsenal in 1943), since the Allies learned very quickly how to counter this threat - with devices towed behind the ship and making a much louder noise than the ship itself. The losses of the submarine fleet were increasing. The reason for this was that the enemy used two revolutionary inventions that are very well known today: the sonar device (echo sounder) and a radar device that was able to detect not only surfaced submarines, but even their periscopes and snorkels.

It should be borne in mind that the main types of submarines used by the Kriegsmarine (in versions VIII and IX, which had been included in the arsenal of weapons) were characterized by a range of around 60 nautical miles under water and were therefore only a type of "submersible". .

There was thus an urgent need to make truly radical changes and design entirely new submarines capable of fighting by means against which the Allies could not defend themselves.

Such submarines were constructed and actually represented the pinnacle of what was technically feasible in this area. Many

Post-war constructions were based on them. These included types XVII, XXI and XXIII.

Although the Type XVII submarine was based on pre-war solutions, it was one of the most interesting. The breakthrough compared to older Type VII and IX units was due to the use of a new engine that was independent of the air supply: the Walter turbine. This invention was already being investigated in the early 1930s. Its inventor was the engineer Hellmut Walter, a chemist from Kiel. It was a turbine engine, for which a classic fuel (diesel fuel) was used, which burned in a special chamber in an atmosphere of oxygen and water vapor. The oxygen came from the catalytic decomposition of 80% perhydrol (concentrated hydrogen peroxide - H_2O_2). So it was a special modification of an ordinary hydrogen peroxide solution, the solution available in pharmacies having a concentration of only three percent. The perhydrol for the one turbine drive was first tested by Walter in [illegible]

Initially he considered the use of concentrated nitric acid as an alternative oxidizing agent, but quickly abandoned it because of its caustic properties and the toxic effects of its decomposition products (mainly nitric oxide), since the leakage of this substance e.g. B. could never be completely ruled out in the interior of the ship. It should not go unmentioned that in Germany, at the time of the construction of the Type XVII submarines, perhydrol was already being produced in industrial quantities in the required concentration and used to drive the turbines that pumped the fuel in the V2 rockets. Since the production capacities were limited and the substance was relatively expensive, both submarines and torpedoes, in which the same propulsion should be used, competed with the V2 rockets, which also had the highest priority.

Work on the Walter turbine to drive a future submarine began as early as 1933 and led to the construction of an engine with an output of 4,000 hp as early as the mid-1930s. During operation, the temperature in its combustion chamber was around 450

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°C and a pressure of 36 atm. Combustion gases and water vapor were used to drive the turbine, after which they were cooled and discharged. The water vapor was condensed and remained in the submarine.

The successful research results led to the ordering of the first test submarine with this drive in 1938. The Germania shipyard got the order. The boat, marked V-80, was completed two years later. It had a static buoyancy of only 80 tons and a crew of three, but made it possible to explore the real possibilities of the new propulsion system.

The results were indeed very promising: during one trip, the V-80 reached a record underwater speed of 28.1 knots. The biggest problem was mainly the high price of the oxidizer. However, the test results were sufficient to make the decision to build a new submarine, this time intended for combat use, of the already mentioned Type XVII. The order for the construction of the first boat (the U-791) was made in 1942, but for various reasons this order was soon cancelled. Four other boats were built: the U-792, the U-793, the U-794 and the U-795. They were relatively small units with a length of 52.1 meters and an underwater static buoyancy of about 330 tons (for comparison, the Type VII submarines had an underwater static buoyancy of up to 865 tons, and the Type IX submarines from 1,232 - 1,804 tons, depending on the version).

Apart from two Walter turbines (each with a maximum output of 2,500 hp), they were also powered conventionally: each of them was equipped with a diesel engine, which - albeit with a relatively small output of 210 hp - was used on the surface, as well as with two "reserve electric motors" with an output of only 75 hp.
The main engines had a working pressure of 30 atm and the temperature in the combustion chamber was around 550 °C.

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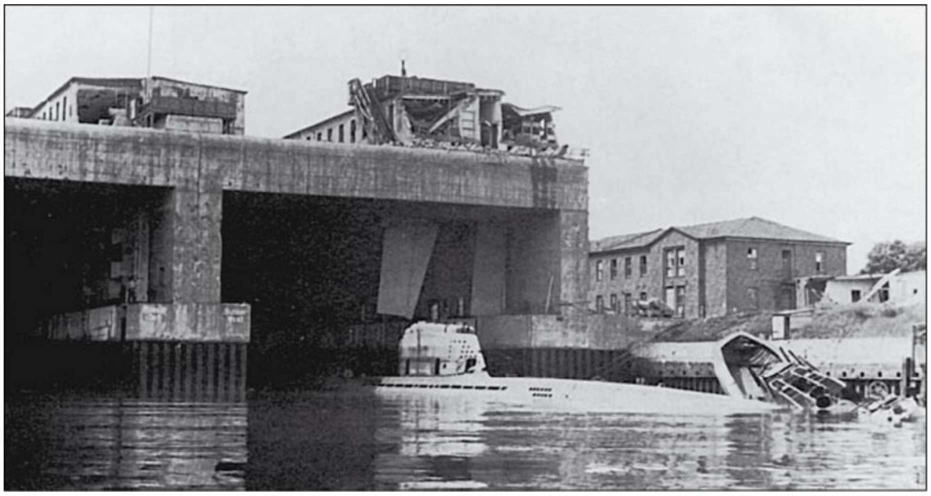
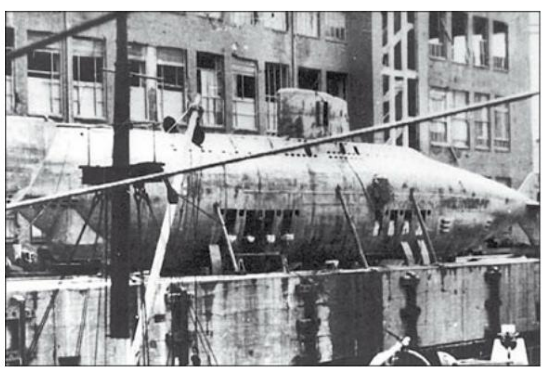


A Type XXI submarine in May 1945 in front of the bunker of the Hamburg shipyard.
(Photo: Federal Archives)

They were the first submarines to reach speeds much faster underwater than on the surface (about 26 knots) and a record range of about 150 nautical miles. However, they could only swim that long and that fast once, and not every time after recharging the batteries, as was the case with conventional submarines. Therefore they were not seaworthy and should do their service mainly in the North Sea.



A Type XVII submarine taken over by the Americans after the war. (Photo: NARA)

They were put into service with the Kriegsmarine at the beginning of 1944, but they only achieved operational readiness in the last months of the war, which is why they never took part in military operations. In the

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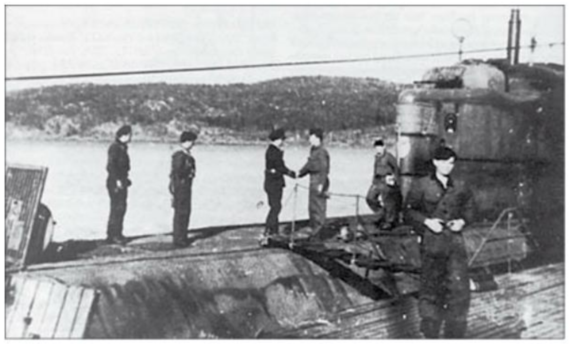
In the first half of 1944, three more units were ordered with a slightly higher static buoyancy and a reduced underwater speed to 21 knots. They were completed in the same year, but were not used. The Germans themselves blew them up towards the end of the war (the officer responsible for this operation was later sentenced to seven years in prison by a British court!).



One of the Type XXI submarines in Norway, April 1945. (Photo from the author's collection)

Even before this happened, three more Type XVII-G and XVII-K submarines and 100 (!) larger Type XVIII offshore units were ordered, but these were never to be completed.

Their proven, revolutionary drive was further developed after the war in the USA, in Great Britain (where Walter himself had been taken) and in the USSR. The USSR was the only post-war country to include submarines powered by Walter turbines in its arsenal.

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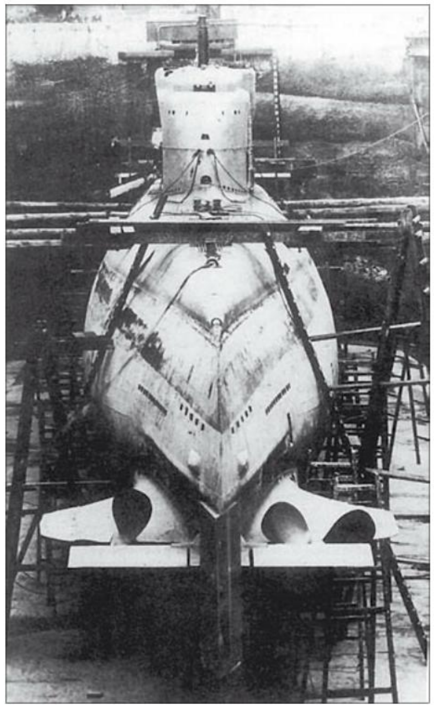

A Type XXI submarine in the ship dock, stern view. (photo from the author's collection)

The relatively small Type XVII-A submarine took on board 40 tons of hydrogen peroxide, which accounted for three quarters of the total amount of fuel and only lasted for 100 miles (although at a speed of over 20 knots). The best way to compare the efficiency of the turbines is with the diesel drive, which consumed the last quarter of the total amount of fuel and enabled a range on the water surface that was around 20 times greater than the first-mentioned drive system.

The drive was further developed until the end of the war and was to be used in some new submarine types: XVIII, XXIII, XXIV, XXVI-A and XXVIII. The first two had a seagoing range - the Type XVIII, for example, could even reach 350 miles thanks to the Walter turbines (with a total output of 15,000 hp!), but had to carry over 200 tons of concentrated perhydrol. The Type XXVI-A was intended to represent a link between the classic solution and the Walter turbines, with the latter only being used in dangerous situations. However, none of these submarines were completed, despite intensive research to increase the

because turbine efficiencies continued this research was redesigned [72,73] The propulsion was simply implied the fundamental limitations of submarines.

There were two reasons for this: First, a submarine (e.g. Type VII or IX) could not flee from a destroyer underwater because it was significantly slower - even twice as slow. Secondly, submarines could only swim underwater for a short time, most often only a few hours, which made them relatively easy to spot, e.g. B. by planes constantly patrolling both the North Atlantic and the access routes to the ports.

The drive parameters have been improved in several ways. The very modern Type XXI (seaworthy) and Type XXIII submarines were equipped with classic propulsion systems (diesel engines plus electric motors), but belonged to a whole new generation and allowed a radical change in tactics. The Type XXI developed a speed of up to 17.2 knots under water, and in one instance it was able to cover 340 miles, i.e. 630 kilometers, powered by the batteries alone! Such a distance was quite a bit greater than that of all its predecessors or competitors. Not only could he easily evade a typical destroyer, dive to the record depth of 330 meters (as one of the tests showed) and engage his targets without surfacing (passive range finder), but he was also particularly difficult to detect underwater.

A Type XXIII submarine. (photo from the author's collection)

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One example was tested in 1946 by the American Navy, whose ships could not even detect the submarine from a distance of 200 meters. The coating of the snorkels with the "Stealth" material naturally also led to a completely new quality on the surface or at the periscope depth.

Generally speaking, this was a leap from the level of the 1940s to the 1960s..This shows how much could be achieved through the successful

exploitation of concepts that had been thoroughly revised, but were quite conventional and broadly known beforehand.

The submarine was equipped with a completely revolutionary fire control system that allowed it to launch effective attacks even when fully submerged. Target positions were determined by converting bearings from very precise receivers, after which the sub fled at a top speed at which the enemy sonars were completely ineffective (they only worked really well up to a speed of 12 knots). So in practice there was no way at all to spot the attacking submarine, while this was almost unavoidable with older types at the end of the war: They were spotted by sonar devices and, in addition, had to extend the periscope before the attack, which the enemy usually does could be detected with the help of radar equipment. But even with this attack variant, the Type XXI was enormously superior to the enemy, because its extended snorkel could not be detected by any radar device due to the special coating.

Another variant of the attack, intended to be used at longer ranges, was the detection of target positions with the help of an extendable radar. For this it was envisaged to use torpedoes equipped with homing devices (e.g. magnetic torpedoes).

Also eliminated was the last of the fatal weaknesses of older submarines, their relatively high vulnerability to air attack, which resulted in part from the inability to detect the aircraft sufficiently quickly. This problem was eliminated by using an onboard radar. In addition, unlike its predecessors, when confronted with a single patrol aircraft (the most typical situation), a Type XXI submarine had very

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great chance of victory, since it was equipped with two anti-aircraft turrets with four 20mm rapid-fire cannons, which could also be linked to the radar. If even these proved insufficient, the submarine was able to submerge in record time (just 18 seconds).

The Type XXI was such a radical leap in quality that – which seemed almost impossible – it tipped the scales even more in favor of the Germans.

It was the first modular submarine - the hull was divided into eight sections that were simply connected to each other in the ship's dock. This simplified the production, but also led (or above all) to the "relocation" of almost all production steps to the ship docks most endangered by bombardments. It was also the first ship to have a single hull, with all the equipment and fixtures housed inside. So far, submarines have been built with a rigid (long and narrow) inner hull, which was first enclosed by ballast containers and only then by an outer hull. This made it possible to significantly increase the space inside the hull and, among other things, to introduce numerous facilities for the crew: each crew member had a whopping 17 m2 of space, there was also air conditioning and washrooms - all things that crews of older types used could only dream of. The crew members were able to take a normal shower, while the sailors who worked on the Types VII and IX, which were riddled with salty moisture and a musty smell, were usually unable to wash for several months, which led to many illnesses.

To supplement the Type XXI U-boat fleet, new Type XXIII "coastal submarines" were planned, which were on the same level of technology but about twice smaller and had a shorter range.

The German attempts to solve the drive problem went in another direction:

It was a diesel engine that had no air supply worked, in a so-called closed circuit.

This was by no means a new concept - the first attempts at implementation date back to the years 1915 - 1918, but it had to be several dozen

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Years go by before technological development has progressed far enough. In 1939, a comprehensive investigation program was started in this area in the Third Reich, with which the following companies, among others, were commissioned:

- Zeppelin GmbH, where under the direction of Dr. Durr to this goal Daimler-Benz diesel engines were modified;
- the Germania shipyard in Kiel - a shipyard responsible for the last phase of the work was responsible;
- the Research Institute for Motor Vehicles – an institute that carried out the bulk of the research work and calculations (Prof. Kamm, Dr. Huber);
- the Junkers-Bessar operations and the Aviation Academy Sotow (in Berlin), which specialized mainly in new torpedo drives (Prof. Holfsleber) and had very valuable experience in this new area;
- the engineers Dipling and Schlefler from Berlin, who used to develop special engines for fast assault boats and brought with them a great deal of knowledge in the field of increasing the efficiency of combustion engines.

On what principle is this innovative type of drive based?

Diesel engines that work in closed circuit are similar in design to classic diesel engines, where the fuel is not mixed with air but with oxygen supplied from the pressure or cryogenic system. The gases resulting from the combustion (carbon dioxide and water vapour) are cooled, causing some of the water vapor to condense and the remaining CO_2 to be easily dissolved in seawater. Only in this form do the combustion products leave the submarine, which only has one propulsion system (possibly an additional special electric drive for slow "creeping up"), which is used both on the water surface and under water. In this way, the underwater swimming time could even be extended to several days and, in the case of the most modern projects of the time, even to several weeks.

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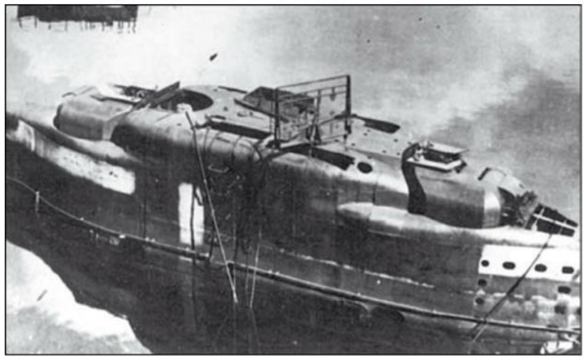
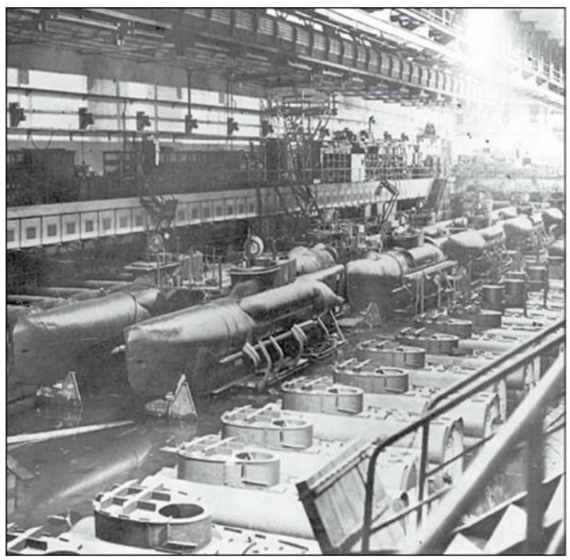


Conning tower of a sunk Type XXI submarine - two anti-aircraft towers can be seen with a radar antenna between them. (Photo: US Army)



Unfinished seal-type miniature *submarines.* (Photo: US Army)

Replacing electric motors and massive batteries with energy sources that are significantly more efficient therefore has decisive advantages.

Daimler Benz engines, mainly of the DB-501 type, were modified for this purpose in the early 1940s. In 1942, two Type IX-D submarines were redesigned, with the original MAN engines (two each) with an output of 2,000 – 2,500 hp being replaced by new, but not yet modified engines from Daimler-Benz.
These were significantly smaller, and since each submarine was to be equipped with six, it was necessary to consider how best to redesign the propulsion component. In this way

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the configuration that came closest to the target configuration could be tested in practice. It was also possible to estimate the properties of the future configuration.

As it turned out, top speed only increased by 2-2.5 knots to around 23 knots (on the water surface), although total power increased from 5,000 hp to 9,000 hp.

It was the first attempt to adapt the new propulsion system for use in production submarines, although before this work was completed it was decided to modify one of the Type XVII submarines, which would be the first to be fitted with the final closed-cycle engines (which, however, was protracted, which is why this submarine was never completed - only some elements of the new system were installed without the engines themselves). It received the marking XVII-K. It was intended that this submarine would carry 23 tons of diesel fuel and about nine tons of compressed oxygen in 16 bottles, which corresponded to a range of about 1,100 - 2,600 nautical miles on the water, depending on the speed. The underwater range, on the other hand, would be approx.

110-120 miles. This submarine, which quickly received the tactical designation U-798, was sunk by the Germans themselves in early May 1945.

It was of course only a pure test construction without armament. The first type to be serially fitted with the new engines was the miniature *submarine Seehund,* which was not much larger than a torpedo. To do this, its fuselage was to be lengthened by a meter and the containers with compressed oxygen replaced with cryogenic tanks, which were much easier to handle. The *seal* had a very short range and the loss of oxygen due to evaporation did not pose a major problem. However, this project was not implemented either, and so none of the engines of the type described built in the Third Reich were ever used at sea.

However, the research work associated with the new idea continued and, despite everything, produced interesting results. In particular, problems with the use of a new fuel mixture in the DB-501 engines came to light. Attempts have been made to eliminate them and to perfect and develop all the peripheral devices.

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Among other things, it was a question of modifying the main source of the problem, namely the system for regulating the injection of diesel fuel and oxygen (in which the high pressure was not always present - initially it was 400 atm, but during the emptying of the tank the pressure dropped to 1 atm). Nevertheless, the ratio between injected fuel and oxygen had to remain the same.

Engine damage occurred due to the water present in the compressed oxygen. The oxygen pressure system, in which small leaks were found despite the great care taken when producing the weld seam, was technically very difficult to implement. On the other hand, there were no problems with the exhaust gas compressor, which was supposed to discharge the combustion gases to the outside – also at great depths, of course.

A special oxygen compressor was also being developed, which would have made it possible to do without some of the pressure tanks, since the oxygen supplies could be replenished on the open sea.

The whole research program described should enable the construction and the start of series production of several new submarine types with the designations XXIX-K (ocean-going), XXXIII (coastal-going, but with an underwater range of 3,000 km!) and XXXIV (coastal-going). The underwater range of the first two models would have been shocking at the time of World War II - at least several times greater than any competing solution. This clearly shows the importance of the concept described.

72.74

In summary, the question can be asked: How could it be that, despite such outstanding technical achievements, the situation of the Navy did not improve? This is a very interesting question to which few know the answer. Of the Type XXI submarines alone, 118 were completed between June 1944 and April of the following year (although a total of 1,300 had been ordered) - none of which, however, managed to sink a single ship. The main problem was that the two modern models, the XXI and XXIII, were much more complex than the previous models. The sailors had to be highly qualified professionals. But it was precisely them that were lacking.

The training took a long time and was only carried out in one facility in Gdynia (Gotenhafen). In the end, most of

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them (1,100 people) surrounded by the Soviet January offensive in the pocket hunt of Danzig/Gdynia at the beginning of 1945. They were to be evacuated by sea; however, the ship on which they had been taken was sunk. It was the famous *Wilhelm Gustloff ...*

Concrete Ships

Another interesting and little-known fact about the German Navy is that as part of the desperate attempts to rebuild the fleet, such incredible (and arguably pointless) concepts as building concrete ships were explored.
However, they were not purely theoretical. The shipyard that was busy was in Darÿowo (Rügenwalde) on the Baltic Sea coast. Even today, the hulls of two such ships are part of the pier in Darÿowo; on a military map one of them is marked with a dashed line as a body measuring 90 x 15 m. Goering once tried to implement a similar idea. At a time when the Allied Air Force was concentrating, among other things, on the destruction of locomotives as one of the "bottlenecks", the Reich Marshal presented the concept of mass production of concrete locomotives.
[13] However, the idea did not find favor, although it does not mean that the leaders of the Third Reich basically acted according to rational criteria. Such dilemmas as the Me-262 bomber versus the Me-262 fighter, or V2 missiles versus anti-aircraft missiles, testify to this. A comparable example are super-heavy tanks.

In this connection I would like to remind you of the comments in my introduction.

Recoilless Weapons

Now that we've gotten to the curious ideas, we can also briefly consider certain interesting concepts in the field of barreled weapons, ammunition and rockets - although they seem decidedly more sensible compared to the ones mentioned above. Many such examples can be found in recoilless weapons, among others. That is often overlooked

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even the *Panzerfaust* at the time of the Second World War was an extremely innovative solution despite its simplicity. Hundreds, if not thousands, of enemy combat vehicles were destroyed by this weapon. It was cheap and simple, consisting mainly of an over-caliber projectile, a primer and a launcher (steel tube).

Nevertheless, the functional principle itself - that the recoil was compensated by the powder gases escaping at the other end of the barrel - was new and was only used in the –, some Second World War. The projectile itself was similarly innovative: Up to this point, it had never been possible to penetrate 10 – 20 cm thick vehicle armor with a slow-moving projectile. The turning point came with a special explosive charge, the so-called HEAT projectile, which has a conical case lined with copper or steel - the so-called hollow charge insert. This is deformed by the explosion, creating a jet of liquid metal with a speed of up to 10 km/s. Exactly this beam then penetrates the armor.

Said principle now made it possible to construct a whole family recoilless weapons.

The recoilless cannon is a light specialty artillery weapon. The concept emerged well before the outbreak of World War II, but the most turbulent development came at the turn of the 1930s and 1940s. Such solutions were developed in various countries (including in Poland shortly before the outbreak of war by the engineer Czekalski), but a particularly large number of models were created in the Third Reich.

A soldier with the Panzerfaust 60 grenade launcher. (Photo: ADM)

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In a recoilless grenade launcher, the barrel is simply open from both sides, while the gun has a breech that allows the powder gases to spread slightly backwards. Its sole purpose is to block the projectile in the barrel and initiate the detonator. The projectile casing is made of a combustible material or of thin perforated sheet metal. The cartridge chamber is designed in such a way that the powder gases pass through the rudimentary breech (the diameter of the chamber is larger than the caliber) and get into the rear part of the barrel, which, as a rule, is terminated with a specially profiled nozzle.

The lack of recoil force allows for a major simplification of the design, including the elimination of the recoil device, which is the main advantage of a recoilless gun. In this way, the light infantry has a replacement for a classic artillery weapon available, which z. B. can be used by airborne troops, mountain troops and reconnaissance subunits. This will enable them to destroy enemy fortified points of resistance (bunkers) and combat vehicles (since the early 1940s, i.e. since the introduction of HEAT shells, since the projectile muzzle velocity of the recoilless gun is too low to core projectiles could be fired effectively).

The *Panzerschreck.* (photo from the author's collection)

So now we come to the main disadvantage of the recoilless gun: the

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low kinetic energy of the projectiles and thus also the low effective range, which does not exceed 1,000 m when shooting straight ahead. This is due to the principle of operation itself - the "leakage" of the cartridge chamber and the lightweight tubular construction.

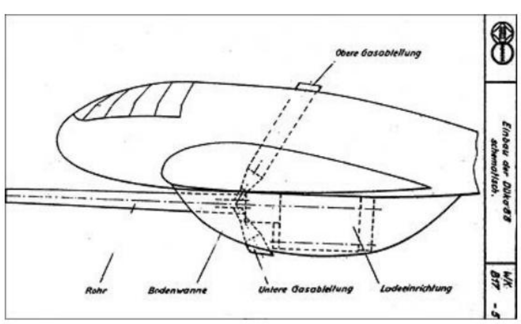
Nevertheless, it was an advanced weapon at the time and invaluable for many applications. The "boom" that could be observed in this area directly after the end of the war is evidence of this. Only several dozen years later, this weapon gradually began to lose its importance due to the introduction of mobile launchers for guided anti-tank missiles.

The German wartime recoilless guns can be divided into two main groups: the relatively conventional designs that were accepted into the arsenal, and the less conventional ones that never got past the experimental or planning stage at the proving ground.

Of course, the most interesting is the second category.[75,76,77]

The projects in question were: 1. A 150mm

gun, thought to have been designed in 1942 (as the marking indicates) and intended to be an addition to the two types mentioned above. Known by the designations LG 42 and LG 292 Rh, it was developed by the same specialists who designed the 75mm and 105mm guns: Engineer Wind and Dr. Biermann (who also designed a bullet weighing 45 kg). Neither the total weight nor the firing range are known. All we know is that the barrel was 2,145 mm long and the bullet's muzzle velocity was probably 290 m/s. Only a few prototypes were made.



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Original drawing of the installation of an 88mm recoilless gun under the fuselage of an aircraft. (Drawing: Rheinmetall).

2. The 88 mm gun DKM-43, developed in Sommerda for the Kriegsmarine as a possible armament for patrol cutters and other small units. Its tube was 2.8 meters long and the total weight was 350 kg. The range is not known, but the high muzzle velocity (600 m/s) indicates a firing range of over 10 km. Firing tests at the test site were positive, but the gun did not go into serial production.

It had an unusual design, completely different from other recoilless guns. 78 The aim was to modify the existing, extremely proven anti-aircraft / anti-tank gun of this caliber. Would it be possible to turn it into a recoilless gun without changing the basic design characteristics?

It turned out that was possible.

A second store was simply placed behind the cannon, in which a second charge exploded when fired, and the resulting recoil compensated for the cannon recoil. However, an unsolvable problem was the situation in which the two explosions could not be precisely synchronized or one charge was not ignited.

3. An aircraft cannon (!) of the same type, which should fire the same type of ammunition, was intended as a development version of the above construction. However, when it turned out that it was too heavy and the plane could not withstand such a powerful explosion (it was of course mainly about the gas jet behind the cannon), the work was interrupted. The tests were carried out on the test site near Treuburg using a modified Ju-87c aircraft. It fired on various tanks set up at the test site. However, when the recoil-compensating charge failed to detonate in one flight, it was badly damaged. Part of the streamlined gun casing was pushed backwards, damaging the aircraft's tail.

78

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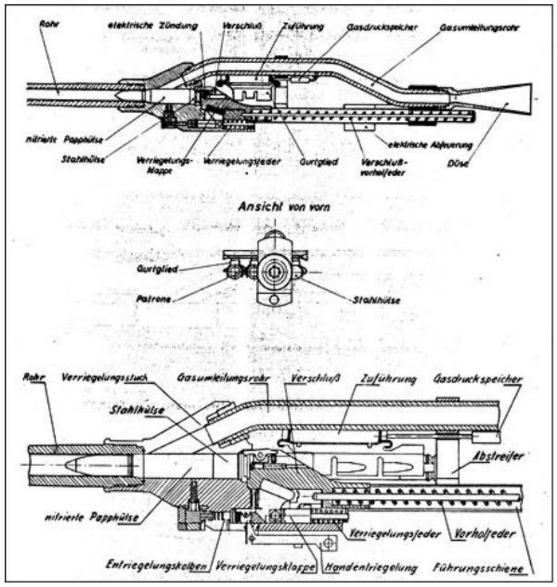
4. A heavy 280mm recoilless gun developed in 1944 for the Kriegsmarine. It was intended for coastal defense before the planned troop landing in France, was intended to arm the heavy bunkers and was supposed to weigh a whopping 28 tons! Since the troop landing took place before the work was completed, it was canceled. The project received the designation DKM-44 (Jet Cannon Marine, 1944 model).



Original cross-sections of the MK-115 automatic recoilless autocannon.

The above unfinished projects represent more of a search for an optimal combination of the advantages of recoilless guns with the advantages of other types of artillery armament. They do not count as truly groundbreaking achievements, but they did happen...

This refers to the recoilless automatic rapid-fire cannon, which was designed in the last years of the war as aircraft armament and was intended to be mounted in the aircraft wings. It is therefore the realization of a concept that is quite unusual and all the more groundbreaking since special cartridges with a partially self-combusting case (cardboard soaked in cellulose nitrate) have been designed for this weapon. Only the base of the case, which sealed the rear part of the chamber during firing, was made of metal. This machine gun received the designation MK-115.

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The starting point for the work was the research results on an earlier, experimental recoilless 50mm aircraft gun and the following specifications of the Air Force Ministry:

• Caliber: 55mm

• Projectile muzzle velocity: 600 m/s • Projectile weight: 1.5 kg; • Minimum rate of fire: 300 rounds/min • Use of carbon steel • Feeding: right or left side • Shot initiation: electric

• Possibility to put the case bases back into the cartridge belt The Rheinmetall-Borsig company took on the task and presented a project for a Autocannon with the following characteristics: 1. The main motto was simplicity, also from a technological point of view. Therefore, the barrel was designed as a monobloc and connected to a cast cartridge chamber by a thread.

2. The main component of the weapon was the chamber, with which the barrel, the breech block, the reloading and feed mechanisms, the gas by-pass tube used to evacuate the powder gases, etc. were connected.

3. The breech was also designed as a monoblock and cast from ordinary carbon steel. The cartridges were electrically fired.

4. One of the most original and unique solutions was the weapon automatics feed system. The shot was fired with the barrel locked, which of course was essential given the energy of the cartridge (locked in the classical meaning of the word, see point 5). The so-called semi-rigid bolt was used – its recoil was slowed down by a special device, which was triggered by powder gases vented sideways through an opening in the chamber (after all, the case did not seal the chamber along its entire length). In the gas pipe connected to the chamber there was a small metal piston, the inertia of which provided the necessary delay in unlocking the pipe. This system

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thus functioned quite differently from the well-known device (which was used e.g. in automatic carbines, as well as in the MP 43 assault rifle, which went into production around the same time, i.e. 1943), whose operating principle was based on the discharge of Gases through a lateral pipe opening is based. This is triggered at a precisely defined time, namely when the projectile comes through at the side opening of the MK-115 autocannon. Unlocking impulse instantaneous, and the rate of fire depended solely on the inertia of the butt and shutter. One reason for choosing this solution was that access to the chamber was not restricted by the (burning through) case. But the main thing was that the reloading cycle should be relatively fast, because unlike automatic carbines, the pressure of the powder gases does not remain particularly stable until the bullet exits, because the barrel is open from the start. This was provided by the gas bypass tube responsible for recoil compensation (it was terminated with a nozzle located in the extended axis of the tube). In this way, the breech recoil was caused directly by the base of the case, on which the powder gases acted, and not (as in the carbines) by the piston rod, which is fed by the gases exhausted from the side tube opening. After the shot, the breech removed the metal case base, during the return movement, which was carried out with the help of a spring, took out the next cartridge and inserted it into the chamber.

5. The problem of removing duds (faulty cartridges) from the barrel was also solved in an interesting way. In the connecting tube between the cartridge chamber and the nozzle installed at the rear, there was a small opening leading to the pressure vessel, in which part of the powder gases were kept under pressure. If necessary, this reservoir supplied the compressed air system responsible for reloading, which was triggered electrically.

Only one prototype of the MK-115 autocannon was built and partially tested before the end of the war. Of course, the tests were only carried out on the ground. The Germans only came to the conclusion that the gun

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worked and actually produced no measurable recoil. It was shot exclusively with single cartridges, because during automatic loading tests it turned out that the base of the case was too weakly connected to the combustible part of the case, which led to damage to the cartridges. There was not enough time to fix this error

...

It has also not been studied how the air blast and shock wave generated behind the autocannon after firing affect the design and engines of the aircraft - this weapon was intended for eventual use in aircraft.

This autocannon would be a complicated but attractive alternative to unguided rocket launchers. The main advantages would be greater accuracy (the projectiles are fired from a rifled tube with a higher initial velocity than rockets) and higher rate of fire, which would increase the probability of hitting the target. 75-77 Generally speaking, recoilless weapons turned out to be very valuable.

It was only thanks to these weapons that the German infantry had a large-scale, effective anti-tank weapon available until the end of the war, increasing the armor of combat vehicles. Strength
It clearly set itself apart from all other armies of the time. in spite of

An important and comparably effective addition to this weapon were anti-tank missile rifles of the *Panzerschreck* type .

Unusual Ideas

A source of much important data on less conventional German concepts is the archive of the Reich Research Council.[79] One of the documents contains, among other things, information about a previously unknown variant of the mentioned weapon.

This document is extremely interesting and found its way into the archive of the "Council" from the Technical SS and Police Academy. It's on the 18th.
Dated January 1, 1945, it lists many different types of weapons that were modern at the time, with part "A" describing those whose development had been completed and part "B" describing those that were still under development. This document

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can be found unabridged on the following pages, but my comment only refers to the most interesting excerpts.

Item A-3 contains rather curious information about the Panzerschreck anti-tank missile *rifle.* There it says:

> "Stimulated by the development of the cardboard [impregnated?] flamethrower [Item A-2], the Academy undertook the development of making the *Panzerschreck* barrel and shield out of cardboard. Development is complete. The devices made of cardboard meet all the requirements quite satisfactorily. The cardboard device is even more resistant to deformation from impact or pressure than the sheet metal device [the launcher was made of 2.5 mm thick sheet steel].
>
> By switching to cardboard, a weight reduction of two kilograms and a saving of 5.5 kg of metal per device is achieved."

The *Panzerschreck* was a light but very effective infantry anti-tank weapon. The missile, equipped with a HEAT warhead, penetrated up to 220 mm thick steel armor, which was able to destroy all existing tanks at the time (calibre: 88 mm). The weapon was also simple and cheap, which allowed it to be used in very large numbers. This is confirmed, among other things, by an analysis from 1951:

19

> "The whole bullet is unusually light and can be made very cheaply from elements that do not require surface finishing (except for the primer socket and the threaded connection). The lack of any exact fits allows mass production of pressed parts."

In the further part of the R2 document we find the next interesting information under point A-5. A detonator is described there that was to be used for acts of sabotage and was triggered in the dark. It was to be attached to trains with the explosive charge - the explosion would occur when the train entered a tunnel. In this way, both the train and the tunnel could be destroyed. On the other hand, point B 1 describes a different, barometric igniter (pressure igniter). It should mainly be used for one-ton bombs

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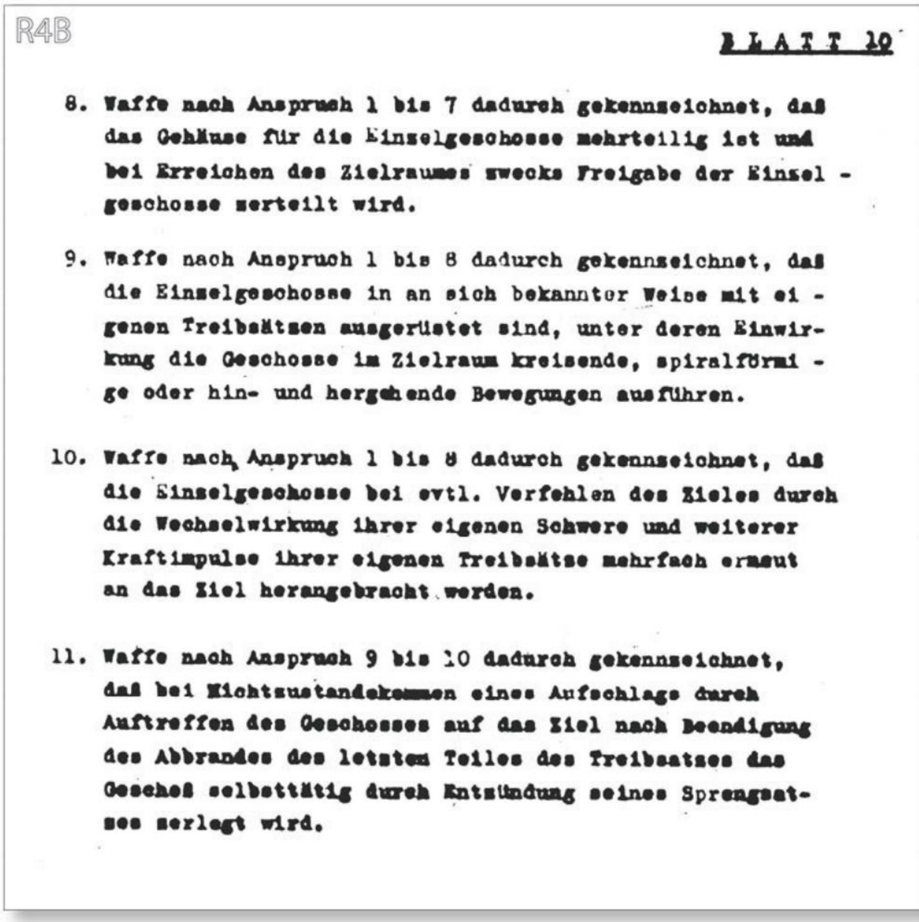
used to bomb enemy bomber formations. It is stated that trials were carried out on the Me-262. I don't know if this concept could be realized, but a one-ton bomb could actually have destroyed an entire bomber formation. It also states that this detonator is much more precise than the previous ones.


R4B

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8. Waffe nach Anspruch 1 bis 7 dadurch gekennzeichnet, daß das Gehäuse für die Einzelgeschosse mehrteilig ist und bei Erreichen des Zielraumes zwecks Freigabe der Einzelgeschosse zerteilt wird.

9. Waffe nach Anspruch 1 bis 8 dadurch gekennzeichnet, daß die Einzelgeschosse in an sich bekannter Weise mit eigenen Treibsätzen ausgerüstet sind, unter deren Einwirkung die Geschosse im Zielraum kreisende, spiralförmige oder hin- und hergehende Bewegungen ausführen.

10. Waffe nach Anspruch 1 bis 8 dadurch gekennzeichnet, daß die Einzelgeschosse bei evtl. Verfehlen des Zieles durch die Wechselwirkung ihrer eigenen Schwere und weiterer Kraftimpulse ihrer eigenen Treibsätze mehrfach erneut an das Ziel herangebracht werden.

11. Waffe nach Anspruch 9 bis 10 dadurch gekennzeichnet, daß bei Nichtzustandekommen eines Aufschlage durch Auftreffen des Geschosses auf das Ziel nach Beendigung des Abbrandes des letzten Teiles des Treibsatzes das Geschoß selbsttätig durch Entzündung seines Sprengsatzes zerlegt wird.

The other sections of the document contain not only curiosities, but above all information about weapons that fully deserve the designation "groundbreaking". Point B-5 describes a new type of gun intended as an alternative to the famous V3 - a multi-chamber gun from Miÿdzyzdroje (Misdroy). However, this complicated device did not work, the construction was also incorrectly calculated and did not withstand the required pressure.

However, point B-5 also describes a solution that makes much more sense

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makes an impression. Externally, this gun would not differ much from a classic long-range gun, although many powder charges were intended to be initiated one after the other. They would move along with the projectile in special containers and be ignited electrically, inductively (through the tube wall). In order to increase the muzzle velocity of the projectile, it was even considered replacing the powder with a special explosive (detonating) explosive, since this would have increased the gas expansion rate to up to 4,000 - 5,000 m/s. This research project is practically unknown and unfortunately no more precise technical data were given...

In addition, one of the accompanying documents (R2F) describes a cannon in which hydrogen is described as the agent for projectile acceleration. These experiments were carried out by Prof. Reyner, also from the Technical SS Academy in Brno. In this context, it was expected that the projectile muzzle velocity would increase to 1,600 m/s. The first prototype should be ready in the spring of 1945.

Point B-6 seems to be a continuation of B-5 - it presents a more perspective plan, but it was well within the range of technical possibilities. The construction of a cannon for liquid fuel (oxygen combined with a petroleum derivative) is described.

From today's perspective, it can be stated that this solution was actually the most advanced. For example, the document highlights the following benefits:

• simple construction

• high energy efficiency • no sleeve

• no detonator

• Increase in muzzle velocity Both points B-6 and B-5 confirm

for probably the first time that this thoroughly groundbreaking work was actually carried out.

The same applies to point B-7, the design work (not of a theoretical nature at all!) on an automatic pistol for caseless cartridges

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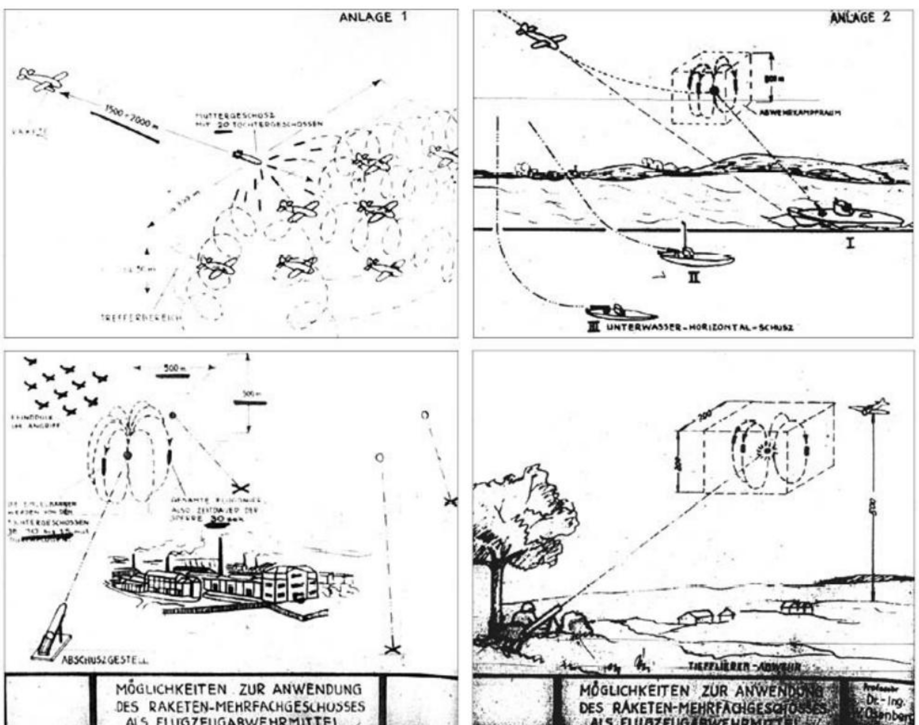
describes. It was developed by order of the Sicherheitsdienst (SD) because it allowed almost complete soundproofing. Normally this is never possible with an automatic gun, since the chamber is opened at a time when there is still relatively high pressure in the barrel, so that the case can be ejected. This property was of particular importance for the security service, *"because the second, third and fourth shot is often necessary in any undertaking with this armament,"* as the document reads.

There is also:

> “The status of the work is such that the shelling is to take place in January or February [1945]. The preliminary tests promise a positive result.”



Zeichnungen als Anlage des R5-Dokuments.

It was not until the mid-1980s that the successful production of small numbers of this type of weapon finally began. It was the Heckler and Koch G11 caseless carbine.

Despite fundamental advantages over a classic carbine (two to three times higher fire efficiency when using a

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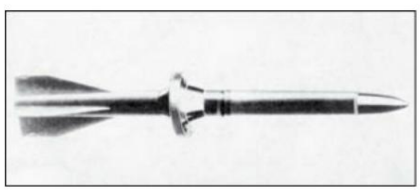
similar mass of ammunition, lower weight of the weapon) it was not included in the arsenal of weapons due to the ammunition standardization at NATO. It had (had) a caliber of 4.74 mm, and it escaped the designation "submachine gun" only because of the high energy of the projectile.

Another document describes the little-known preparations for combat use of some 214mm caliber air-to-air missiles. They weighed 100 kg and were fitted with a 40 kg mine/incendiary warhead containing 400 preformed fragmentation charges. These shells were tested by the Jägerregiment from Parchim (JG-10). The first batch arrived there at the end of 1944. A technical drawing of the bullet was printed.

Document R4 also refers to unguided anti-aircraft weapons. It is a patent specification for many proposed anti-aircraft versions of the *Panzerfaust* and *Panzerschreck models.* Three versions can be seen on the original drawings by Prof. Osenberg: a rocket version, a recoilless version and a version corresponding to the mortar.
The drawings are interesting in that they depict very different concepts from the final model of the *Fliegerfaust* rocket launcher , which was produced in a limited number. The drawings mentioned can be found on the previous pages as figures R4C and R4D.



Another concept that turned out to be forward-thinking: a fin-stabilized subcaliber projectile designed for a 280mm gun – the range was increased to 150km as a result! (photo from the author's collection)

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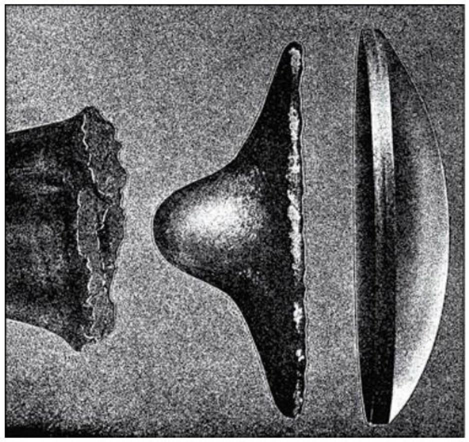

Individual phases of explosive bullet formation - a compilation of images from the Rheinmetall company.

Technische SS - und Polizei-Akademie

R2A

Berlin, den 18. Januar 1945.

Geheime Reichssache!

zu Ted z 966/45 (g.Rs.)

Anlage.

A. Abgeschlossene Arbeiten.

1. MG-Lafette mit Fahrgestell.

Die Lafette mit Fahrgestell ist am 12. und 13. Dezember 1944 in Suhl dem Sonderausschuss Infanteriewaffen vorgestellt worden und hat sich beim Beschuss sowohl mit dem MG 34 als auch MG 42 bewährt. Z.Zt. wird vom Heereswaffenamt die Lafette auf Truppenbrauchbarkeit geprüft.

2. Einstossflammenwerfer.

Der von der Akademie zusammen mit dem Heereswaffenamt entwickelte Einstossflammenwerfer befindet sich in Grossfertigung. Die Akademie hat nunmehr die Entwicklung dahingehend weiter betrieben, dass der Einstossflammenwerfer statt aus Blech aus Pappe gefertigt wird. Die abgeschlossenen Versuche haben ergeben, dass die Ausführung aus Pappe allen Anforderungen entspricht.

Die Metalleinsparung beträgt pro Werfer 485 g bei einem Gesamtgewicht des Werfers von 1625 g.

3. Panzerschreck.

Angeregt durch die Entwicklungsarbeiten des Flammenwerfers aus Pappe hat die Akademie die Entwicklung betrieben, Rohr und Schutzschild des Panzerschrecks aus Pappe zu fertigen. Die Entwicklung ist abgeschlossen. Die aus Pappe gefertigten Geräte entsprechen allen gestellten Anforderungen durchaus befriedigend. Das aus Pappe gefertigte Gerät ist sogar gegen Deformieren durch Stoss oder Druck widerstandsfähiger als das Blechgerät. Durch die Umstellung auf Pappe wird eine Gewichtsverminderung von 2 kg und eine Einsparung von 5,5 kg an Metall pro Gerät erreicht.

4. Mehrstossflammenwerfer.

Die Entwicklung eines Einkessel-Mehrstossflammenwerfers für 8-10 Flammstösse wurde abgeschlossen. Es wurde an Stelle des mit Stickstoff gefüllten Druck[illegible]ters eine Pulverpatrone verwendet, die sich im Öl[illegible] des Werfers befindet und durch einen Abreisszünder [illegible]tätigt wird.

Dieses mittels Pulverdruck arbeitende Mehrstossflammenwerfergerät ist fertigungs-, bedienungs- und [illegible]schubmässig (Fortfall der Stickstoffflasche) sehr viel einfacher als das Stosstruppgerät 41.

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R2B

5. **Verdunklungszünder.**

Für den Sicherungsdienst wurde ein Lichtschalter für Sabotagezwecke entwickelt, der eine Sprengladung bei Eintritt der Dunkelheit zum Entzünden bringt (z.B. zum Sprengen von Tunnels usw.).

6. **Entlastungsmine.**

Die Entlastungsmine ist eine Mine, die, wie der Name sagt, dann zur Auslösung kommt, wenn ein auf ihr liegender Gegenstand entfernt wird. Sie eignet sich besonders für Sabotagezwecke, Verminung von Häusern und dergleichen. Für die Verwendung dieser Mine ergeben sich, auf Grund ihrer Konstruktion, unzählige Möglichkeiten.

Die Entlastungsmine ist dringend von den ɮ-Jagdverbänden gefordert worden. Der Vorläufer dieser Mine war sprengstoffmässig gesehen leichter und hat sich bereits im Einsatz bewährt.

Von der Akademie ist die Fertigung von monatlich 100 - 200 Stück aufgenommen worden. Die ersten 100 Stück werden am 17.1.1945 ausgeliefert.

B. In Entwicklung befindliches Gerät.

1. **Barometrischer Zünder.**

Diese Zünderart ist seit langer Zeit bekannt, konnte aber wegen zu grosser Ungenauigkeit bisher nicht mit Erfolg eingesetzt werden.

Es gelang in wenigen Wochen in Zusammenarbeit mit O.K.L. einen voll brauchbaren Zünder zu entwickeln.

Verwendung: a) Bekämpfuhg feindlicher Pulks durch Abwurf von 1000 kg-Minenbomben.

Bedienung des Zünders ist derart verei[illegible] facht worden, dass der Pilot lediglich [illegible] Höhe des feindlichen Pulks, aber in [illegible] rem Abstand von diesem, einen elektrisc[illegible] Kontakt zu betätigen hat. Er kann dann [illegible] einer beliebigen Zeit und aus beliebige[illegible] Höhe seine Minenbombe abwerfen. Sie wir[illegible] genau in Höhe der feindlichen Maschinen [illegible] knallen.

b) Für alle Geschosse, die in einem besti[illegible] Abstand vom Erdboden zum Zerknallen ge[illegible] werden sollen.

Z.Zt. finden Abwurfversuche statt mit einer Masch[illegible] des Baumusters Me 262.

2. **Stahlvergütung.**

Durch ein neu entwickeltes, sehr einfaches Wärmebe[illegible]

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R2C

handlungsverfahren ist es gelungen, die Zähigkeit von chrom- usw. armen Stahlen wesentlich zu verbessern.

2 cm-Geschützrohre, die nach bisherigen Härteverfahren bei 5 g Sprengstoff aufrissen, hielten nach dem neuen Verfahren bis 11,5 g.

Das Verfahren wird z.Zt. in Zusammenarbeit mit Ministerium Speer und Heereswaffenamt fabrikationsreif gemacht.

3. Munitonswirkung im Ziel.

Auf Veranlassung des Heereswaffenamtes und des O.K.L. wird das Eindringen von verschiedenen Geschossformen im Ziel mit neuartigen Mitteln untersucht. Wichtig für Verbesserung der Munition und für die Vereinfachung von Abwehrkonstruktionen.

Für Kaliber vis 10,5 cm und mittlere Auftreffge - schwindigkeiten werden Ergebnisse in Kürze vorliegen.

4. Beton-Handgranate und Papp-Handgranate.

Angeregt durch den Engpass Sprengstoff wurde die Entwicklung von Handgranaten aufgenommen, die bei gleicher Splitterwirkung mit weniger Sprengstoff auskommen.

1. Ausführung Splitterbeton.

Der Handgranatenkörper wird aus einer Mischung von Beton und Schrottabfällen gegossen und benötigt zur Zerlegung wegen des geringen Energiewufwandes zum Zerreissen der Hülle und der bereits fertigen Splitter etwa 1/2 bis 1/3 (80–40 g) von der sonst in der Stielhandgranate benötigten Sprengstoffmenge (180 g). Bei dem Vergleich der Beton-Handgranate und der normalen Handgranate hat sich gezeigt, dass mit einem Splittergewicht von ca. 300 g bei 50 g Sprengstoff die Wirkung der Beton-Handgranate der normalen Handgranate überlegen war. Der Nachteil besteht im Gewicht der Granate. Bei Wurfversuchen lag die Reichweite etwa 10 m kürzer. Der Vorteil dieser Beton-Granate besteht darin, dass sie leicht in Heimarbeit herzustellen ist und so für Volkssturmverbände besonders gut geeignet ist. Sie lässt sich in Verbindung mit dem Zugzünder ZZ 42 auch als Schützenmine verwenden. Bei dieser Verwendung spielt das Gewicht keine Rolle.

2. Papp-Handgranate.

Zu der Ausführung der Handgranate in Pappe ist bis auf das Gewicht das Gleiche wie zu der Ausführung aus Beton zu sagen. Die Papp-Handgranate benötigt voraussichtlich bei gleichem Gewicht wie die eingeführte Stielhandgranate nur etwa 1/3 Sprengstoff bei gleicher Spreng- und Splitterwirkung.

Durch diese Entwicklungen wird ausser der Einsparung an Walzblech- und Sprengstoffkapazität wegen der einfachen Fertigung die Produktion wesentlich gesteigert.

R2D

5. **Wesentliche Erhöhung der Anfangsgeschwindigkeit von Geschossen.**

Auftrag des Reichsluftfahrtministeriums. Es sind zwei Wege beschritten worden und zwar:

a) **Geschoss mit Kaskaden-Kartusche,**
d.h. ein Artillerie-Geschoss wird mit mehreren Kartuschen versehen, die nacheinander im Geschützrohr zur Zündung gebracht werden. Die erste Kartusche wird wie üblich gezündet, die weiteren, die ja mit dem Geschoss mitfliegen, müssen durch die Rohrwand des Geschützes hindurch gezündet werden.

Die Versuche haben ergeben, dass durch einen Induktionsstrom eine einwandfreie Zündung durch die Rohrwand hindurch möglich ist.

b) **Antrieb durch Detonationsgase.**
Ersatz des Pulvers zum Antrieb durch Sprengkörper. Die Schwadengeschwindigkeit der Detonationsgase liegt bei 4-5000 m/sec.

Die Versuche sind sehr schwierig; es scheint aber mit Hilfe von Hohlraumsprengkörpern eine Lösung möglich zu sein.

6. **Kraftstoff-Kanone.**

Hierunter wird eine Waffe verstanden, die an Stelle von Pulver mit Diesel- oder Otto-Kraftstoff unter Zusatz von Sauerstoff genau wie ein Motor arbeitet, nur wird an Stelle des Kolbens ein Geschoss vorwärtsgetrieben.

Gelingt es, eine ausreichende Beschleunigung des Geschosses zu erreichen, so sind die Vorteile sehr gross z.B.

einfache Konstruktion,
geringer Energiebedarf,
Wegfall der Kartusche,
Wegfall des Zündhütchens,
grössere Schussgeschwindigkeit.

7. **Automatische Pistole mit kartuschfreier Munition.**

Die Entwicklung einer solchen Waffe wird besonders vom Sicherheitsdienst gefordert.

Bei dieser Waffe handelt es sich im wesentlichen um eine Pistole, die voll automatisch schallgedämpft schiesst. Bei den bisherigen Konstruktionen war ein automatisches Schiessen nicht möglich, da beim Öffnen des Verschlusses die Waffe unverändert knallt. Zur Erreichung des genannten Zieles musste also gesorgt werden, dass die Waffe während ihrer Funktion vollkommen geschlossen bleibt. Diese Bedingung kann nur dadurch erfüllt werden, dass eine Munition verschossen wird, die ohne Rückstand (Kartusche) den Lauf verlässt - kartuschfreie Munition -. Die Munition ist nach dem Prinzip der Rakete aufgebaut.

Der Stand der Arbeiten ist so, dass im Januar [illegible] bruar der Beschuss erfolgen soll. Die Vorversuche [illegible] chen ein positives Ergebnis.

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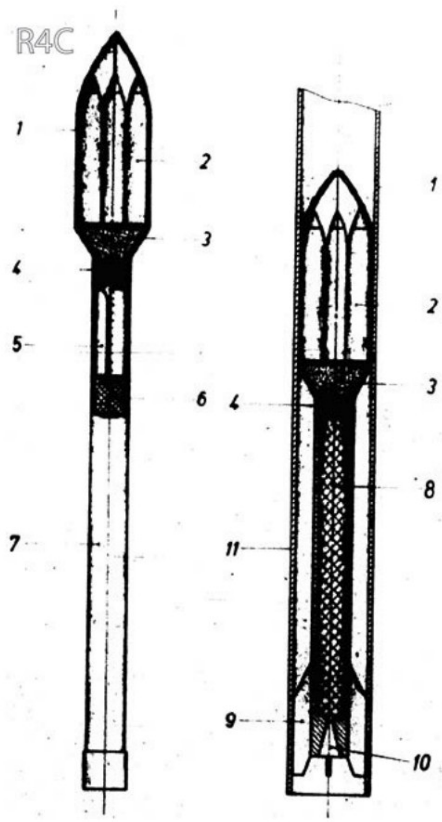
R2E

Die Forderung einer solchen Waffe ist deswegen gestellt worden, weil bei irgendwelchen Unternehmungen mit dieser Bewaffnung oft der zweite, dritte und vierte Schuss notwendig wird.

8. Pionier-Zugzünder ZZ 42.

Der bei der Wehrmacht eingeführte Pionier-Zugzünder besteht aus einem Bakelit- bzw. Stahlgehäuse. Der Zünder wird als Zug- und Zerschneidezünder verwendet. Von der Akademie ist die Entwicklung betrieben worden, das Gehäuse dieses Zug- und Zerschneidezünders aus Pappe zu fertigen, wodurch Bakelit bzw. Stahl eingespart wird.



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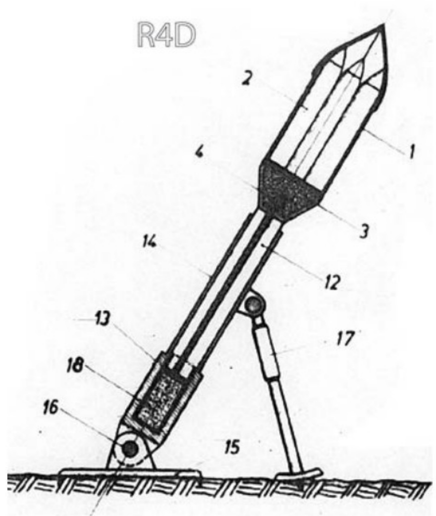

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R2F

Bericht über die Besprechung bei GL-Flak E
am 22.8.1944 in Berlin.

Gegenstand der Besprechung: Die Erzielung einer hohen V_o durch neuartige Waffen.

Von den in der letzten Besprechung im Juni behandelten Möglichkeiten wurden neuerdings behandelt:

Progressive Pulverladung: Die Entwicklung leidet unter geringfügigen Herstellungsschwierigkeiten, so dass praktisch nichts geschieht. Erhofft wird eine V_o-Steigerung auf 2000 m/sek. durch die Mischung von Pulver und zeitlich nachdetonierendem Sprengstoff.

Mehrfach-Ladungen: Die Anwendung von mehreren nacheinander zur Entzündung zu bringenden Pulverladungen würde ausführlich besprochen, doch scheint ein Erfolg nur bei Verwendung extra langer Rohre, d.h. der Entwicklung eigener Geschütze gegeben zu sein. Praktisch geschieht auf diesem Gebiet nichts.

Wasserstoff-Kanone: Ein von Prof. Reyner entwickeltes Wasserstoff-Geschütz wird bei der Technischen Akademie der SS in Brünn Vorversuchen unterzogen, die gegenüber Pulvertreibmitteln eine Wirkungsgradverbesserung von 1 : 1,7 ergaben. Man erwartet eine V_o von 1600 m/sek. Die Fertigstellung einer Erprobungsreifen-Konstruktion dürfte aber noch 6 bis 9 Monate dauern.

F-Mine: Prof. Schardin berichtete über die weitere Entwicklung seiner Mine, deren Wirkungsgrad mit 30 - 40 % bereits den von Geschützen erreicht hat. Die tatsächlichen Fluggeschwindigkeiten der Stahlscheiben liegen wohl weit unter den 3000 m/sek. der Modellversuche bei 1800 m, doch konnte er einen neuen Effekt studieren. Statt der homogenen Scheibe verwendete er eine aus 120 Stückchen bestehende Einlage, die bei Detonation in ganz engen Streuwinkel mit ca 2000 m/sek. abgeschossen wurden, also eine ideale Schrotwirkung für Schrapnellgeschosse ergaben. Die weitere Entwicklung der F-Mine soll nun mit uns in Richtung einer Jäger-Mine zur Bomberbekämpfung mit Brandschrapnell's erfolgen. Konstruktiv und fertigungstechnisch wurden eine Reihe von zu bearbeitenden Aufgaben mit einzelnen Sachbearbeitern von GL-Flak durchgesprochen.

Lindau, den 24. August 1944
Dr.Doe/Si.

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R4A

BLATT 9

PATENTANSPRÜCHE

1. Waffe insbesondere zur Bekämpfung von Flugzeugen dadurch gekennzeichnet, daß das Geschoß aus einem eine Mehrzahl von Einzelgeschossen aufnehmenden stromlinienartig ge - stalteten Hohlkörper besteht, der aus einem Rohre mittels eines Treibsatzes, eines Raketenantriebes oder einer Treibladung ausgestoßen und nach dem Zielraum überführt wird.

2. Waffe nach Anspruch 1 dadurch gekennzeichnet, daß der die Einzelgeschosse aufnehmende Hohlkörper an seinem rückwär- tigen Ende ein Leitwerk trägt, das in ein mit einem Treib- satz ausgestattetes Abschußrohr eingesetzt ist (Figur 1).

3. Waffe nach Anspruch 1 dadurch gekennzeichnet, daß der die Einzelgeschosse aufnehmende Hohlkörper an seinem rückwärtigen Ende einen Raketenantrieb mit Leitflächen trägt, wobei der Abschuß aus einem Führungsrohr heraus erfolgt. (Figur 2)

4. Waffe nach Anspruch 1 dadurch gekennzeichnet; daß der die Einzelgeschosse aufnehmende Hohlkörper an seinem rückwärtigen Ende ein Führungsstück und daran anschlies- send einen Treibspiegel trägt, wobei der Abschuß aus einem Rohr mittels einer Treibladung erfolgt (Figur 3).

5. Waffe nach Anspruch 1 bis 4 dadurch gekennzeichnet, daß das Abschußrohr als Handwaffe ausgebildet ist.

6. Waffe nach Anspruch 1 bis 4 dadurch gekennzeichnet, daß das Abschußrohr auf einem Gestell mittels Richtmitteln einstellbar nach Art eines Werfers oder Düsengeschützes angeordnet ist.

7. Waffe nach Anspruch 1 bis 6 dadurch gekennzeichnet, daß der die Einzelgeschosse aufnehmende Hohlkörper einen Sprengsatz mit einem einstellbaren Zeitzünder enthält.

Prof. Osenberg (head of the "Council's" planning office) was the originator of even stranger, but perfectly reasonable concepts, which were described and illustrated in document R5. It talks about unguided, circling anti-aircraft missiles! With them it would be possible to set up a kind of "anti-aircraft fire barrage" that would be maintained independently for a certain period of time. So the rocket projectile could hit an air target with more probability compared to the straight trajectory

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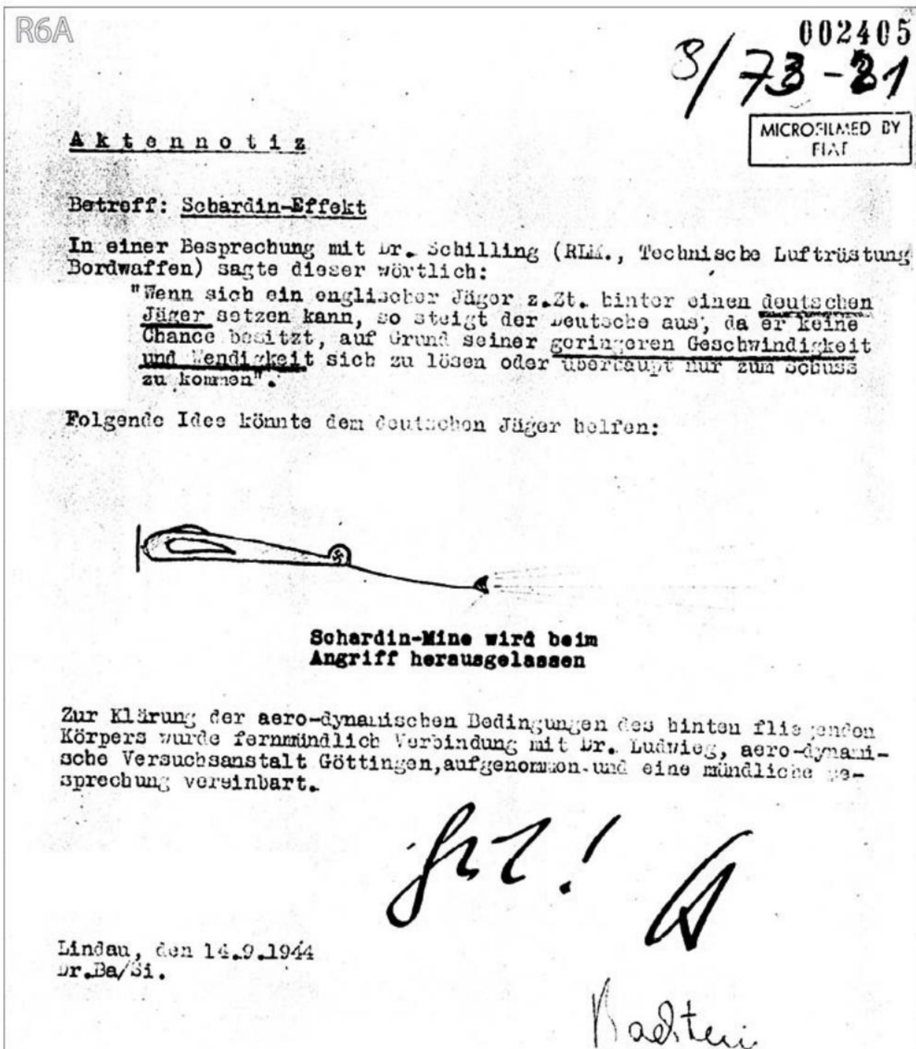
hit, all the more so because different fragmentation warheads were developed at the same time - warheads that distributed autonomously circling projectiles in the target area. Osenberg wrote that the first version would be ready for trials by the end of February 1945, but low-volume (500 units) series production would begin in early May. This only applied to the air-to-air version with a "large number" of sub-munitions capable of about 10-15 loops in about 30 seconds.

There is nothing to indicate that the Germans managed to conduct firing tests on any of these versions. After the war, however, this concept was not further developed.



R6A

002405

8/73-81

MICROFILMED BY FIAT

Aktennotiz

Betreff: Schardin-Effekt

In einer Besprechung mit Dr. Schilling (RLM., Technische Luftrüstung Bordwaffen) sagte dieser wörtlich:

"Wenn sich ein englischer Jäger z.Zt. hinter einen deutschen Jäger setzen kann, so steigt der Deutsche aus, da er keine Chance besitzt, auf Grund seiner geringeren Geschwindigkeit und Wendigkeit sich zu lösen oder überhaupt nur zum Schuss zu kommen".

Folgende Idee könnte dem deutschen Jäger helfen:

Schardin-Mine wird beim Angriff herausgelassen

Zur Klärung der aero-dynamischen Bedingungen des hinten fliegenden Körpers wurde fernmündlich Verbindung mit Dr. Ludwieg, aero-dynamische Versuchsanstalt Göttingen, aufgenommen und eine mündliche Besprechung vereinbart.

Lindau, den 14.9.1944
Dr.Ba/Si.

Baditen

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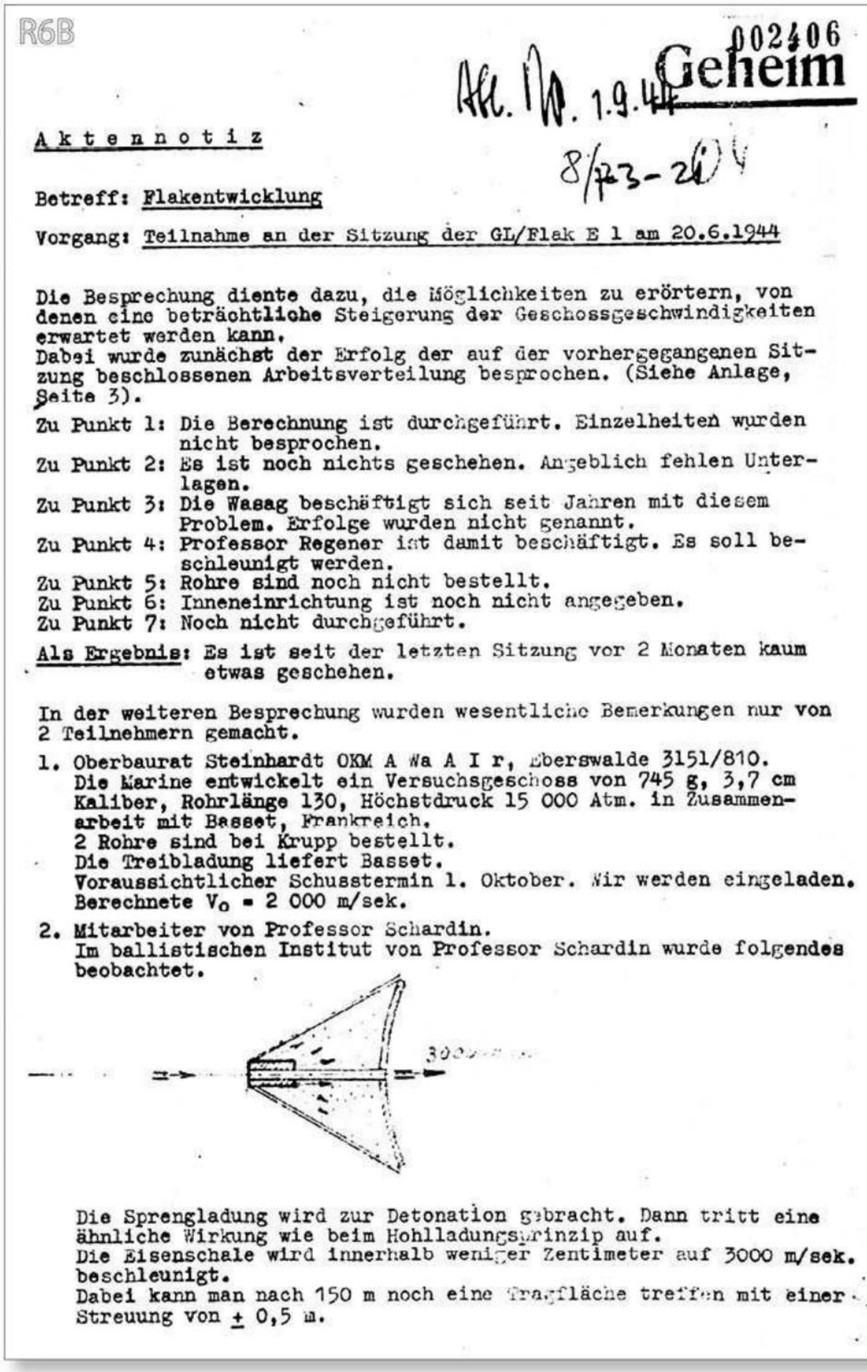


R6B

002406

Akt. Nr. 1.9.44 **Geheim**

8/73-20

Aktennotiz

Betreff: Flakentwicklung

Vorgang: Teilnahme an der Sitzung der GL/Flak E 1 am 20.6.1944

Die Besprechung diente dazu, die Möglichkeiten zu erörtern, von denen eine beträchtliche Steigerung der Geschossgeschwindigkeiten erwartet werden kann.
Dabei wurde zunächst der Erfolg der auf der vorhergegangenen Sitzung beschlossenen Arbeitsverteilung besprochen. (Siehe Anlage, Seite 3).

Zu Punkt 1: Die Berechnung ist durchgeführt. Einzelheiten wurden nicht besprochen.
Zu Punkt 2: Es ist noch nichts geschehen. Angeblich fehlen Unterlagen.
Zu Punkt 3: Die Wasag beschäftigt sich seit Jahren mit diesem Problem. Erfolge wurden nicht genannt.
Zu Punkt 4: Professor Regener ist damit beschäftigt. Es soll beschleunigt werden.
Zu Punkt 5: Rohre sind noch nicht bestellt.
Zu Punkt 6: Inneneinrichtung ist noch nicht angegeben.
Zu Punkt 7: Noch nicht durchgeführt.

Als Ergebnis: Es ist seit der letzten Sitzung vor 2 Monaten kaum etwas geschehen.

In der weiteren Besprechung wurden wesentliche Bemerkungen nur von 2 Teilnehmern gemacht.

1. Oberbaurat Steinhardt OKM A Wa A I r, Eberswalde 3151/810.
   Die Marine entwickelt ein Versuchsgeschoss von 745 g, 3,7 cm Kaliber, Rohrlänge 130, Höchstdruck 15 000 Atm. in Zusammenarbeit mit Basset, Frankreich.
   2 Rohre sind bei Krupp bestellt.
   Die Treibladung liefert Basset.
   Voraussichtlicher Schusstermin 1. Oktober. Wir werden eingeladen.
   Berechnete V_0 = 2 000 m/sek.
2. Mitarbeiter von Professor Schardin.
   Im ballistischen Institut von Professor Schardin wurde folgendes beobachtet.

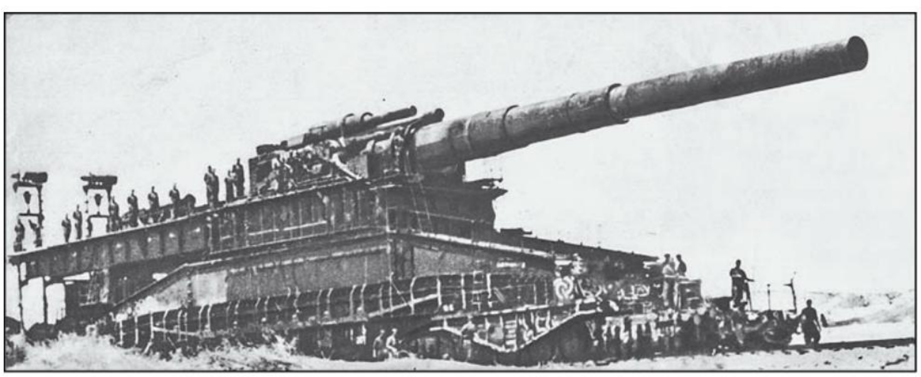
Die Sprengladung wird zur Detonation gebracht. Dann tritt eine ähnliche Wirkung wie beim Hohlladungsprinzip auf.
Die Eisenschale wird innerhalb weniger Zentimeter auf 3000 m/sek. beschleunigt.
Dabei kann man nach 150 m noch eine Tragfläche treffen mit einer Streuung von ± 0,5 m.

However, the situation was different with an idea described in the set of documents marked R6. These documents refer to the concept of "explosive formation (and acceleration) of projectiles" referred to in wartime German nomenclature as the "Schardin effect." This discovery started in

Machine Translated by Google

the United States when in 1936 the physicist RW Wood observed the formation of a spherical shrapnel, a mini-projectile, from the concave forehead of a detonator which he accidentally threw into the furnace (an investigation was launched as this shrapnel killed a human being). However, only the Germans took advantage of this phenomenon during the war, designing a whole family of anti-tank charges. This research was already in an advanced stage in 1940. In 1944, Osenberg wrote that he had managed to achieve a very high initial bullet velocity of 3,000 m/s and limited its spread to about 0.5 meters at a distance of 150 m.

The super-heavy mortar *Thor.* (Photo: *The Wehrmacht)*



The super-heavy (800 mm) gun *Gustav* in Rügenwalde. It certainly wasn't the best solution from an economic point of view, but it still had a few unique advantages. One of the most significant was probably that the projectile in extreme

depth - usually 35-40 meters(!) - below the surface of the earth. Normally this wasn't necessary, but when attacking important defenses this quality became invaluable. In 1942, for example, *Gustav* was able to destroy the ammunition depot of the Sevastopol fortress. (Photo: *The Wehrmacht)*

Facts that are particularly little known include the development of the "Schardin mine", intended to tow a fighter plane as a weapon of self-defense, and a two-part projectile explosive plate as intended to accelerate a second projectile stabilized by fins (see drawings on the previous pages). An anti-tank warhead of this type was also developed on behalf of the Kriegsmarine.

However, this was not the end of Professor Osenberg's inventive talent! The set of documents marked as R7 describes another unusual idea (also developed further after the war) in the form of a patent specification including drawings. This time it was an airborne anti-tank weapon, a major evolution of the *Panzerfaust,* which differed from its predecessor, among other things, in that the projectile fired from a recoilless tube consisted not only of a HEAT charge (which in this case was specifically designed to penetrate concrete had been developed), but also of a second recoilless projectile intended to penetrate the interior of the target through the opening created by the first charge.

This second projectile had a delay fuse and was stabilized during flight by fins that were deployed after the shot was fired.

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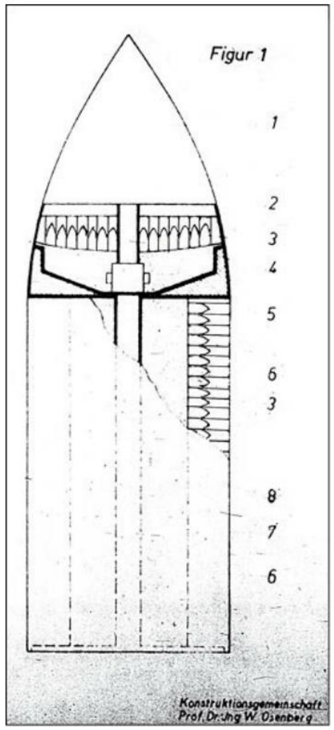
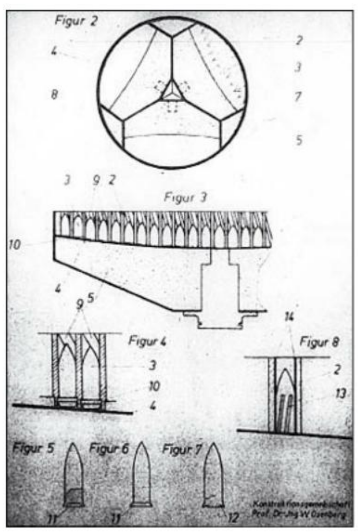


R7



Drawings accompanying the patent specifications.

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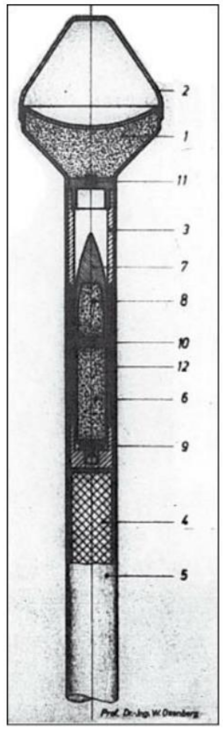

R8

It is not known if the Germans were able to test this weapon until 1945; however, the results obtained after the war indicate that it was literally a technical "bull's-eye". A whole group of very effective weapons for the destruction of bunkers, air raid shelters and runways was created - the projectiles exploding under the concrete slabs of runways usually cause irreparable damage. The set of documents marked with the symbol R8 describes.yet another (and by no means the last) invention Osenberg's.

Here we are again dealing with a precise patent specification, this time accompanied by a report of the tests carried out on a proving ground.

It describes an artillery fragmentation shell with a completely atypical design, which was characterized by a much longer range and fragment penetration ability than usual. Its hull is divided into four parts or panels: a front panel and three side panels. Each of these plates has dozens to more than a hundred drawn (grooved) openings in which the formed fragments are already located. These fragments were actually miniature projectiles with a twist stabilizer

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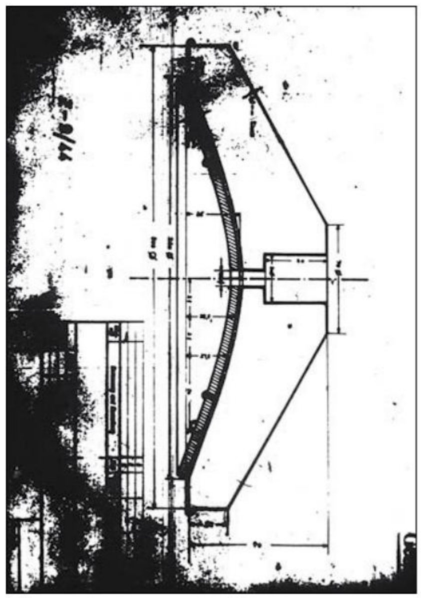
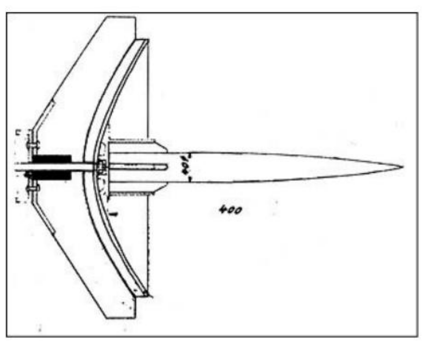
during the flight. This solution was certainly much more expensive than a cast shell, but a significant increase in effectiveness on specific targets was undeniable. The practice of military-technical development shows that it is often cheapest to increase the effectiveness of a given weapon system by modernizing its ammunition. There are many examples in history where spending in this area has always paid off.



This drawing by Professor Schardin looks deceptively similar to the projects from the 1980s. Unfortunately, their quality leaves much to be desired.



A modified project based on the explosive acceleration of a fin stabilized anti-tank missile.

On January 24th and 26th (probably in 1945) the first tests with this ammunition were carried out near Redlin. Around

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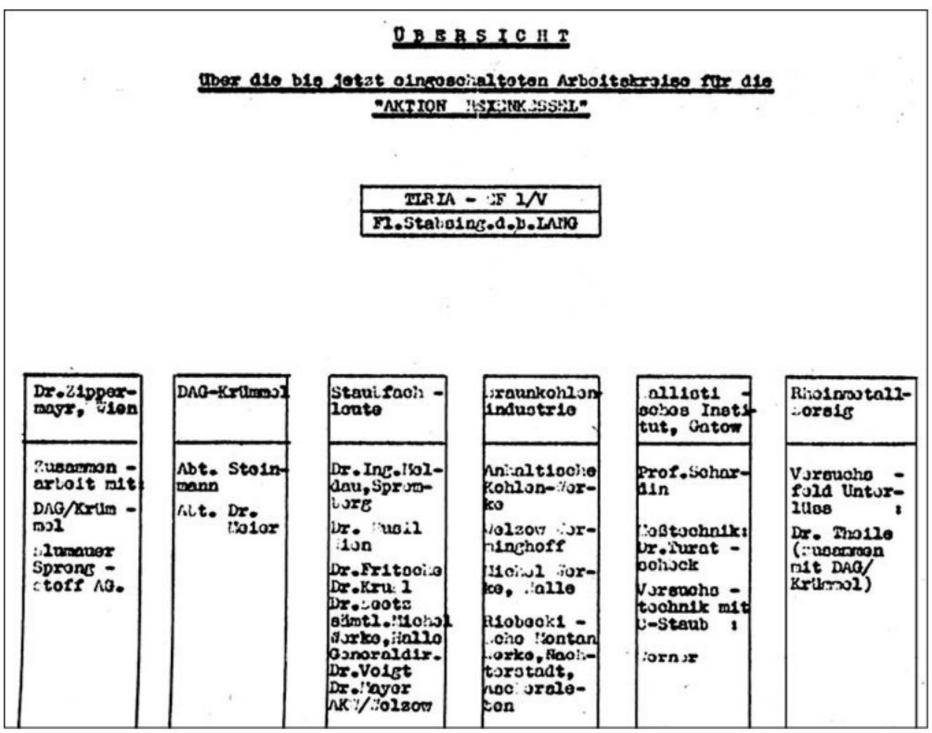
In order to be able to follow the fragmentation flight lines more easily, a frozen lake with an approx. 35 cm thick layer of ice was chosen as the test surface, on which the "targets" were placed: a vertically erected plywood panel measuring 6 x 5 meters and behind it a wing of the Focke-Wulf 190, a pair of armor plates with a thickness of 5 mm and an area of 0.5 m2 each, and two empty fuel rubber containers with a wall thickness of 10 mm. 150 meters in front of this "structure" a 1 meter high block of wood was set up, on top of which was a warhead of the type mentioned, marked 240/5. The warhead weighed 39 kg. With the help of an optical device, it was guided to the target and then electrically ignited. Its efficiency was amazing.

Although the fragment trajectories were generally scattered in an angular cone of 26°, 38 hit the vertically erected "protective shield". Two shrapnel penetrated the FW-190's wing. Two penetrated the wall of the fuel tank and remained inside, one of which was a squib. One of the armor plates showed hit marks, but it was not penetrated. At the site of the explosion, however, a hole was formed in the ice with a diameter of 1.5 meters.



Organizational chart for the *Hexenkessel project.*

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Four more attempts were later made, gradually reducing the distance to the target and setting up a tank filled with fuel. An increasing number of hits could be observed. Although some of the fragments were supposed to ignite, the fuel did not catch fire. The armor plates were not penetrated either, although they were clearly deformed at the smallest distance of 45 meters. The last attempt was conducted with a missile equipped with the 240/5 warhead and fired from a low-flying FW-190 fighter. After a few hundred meters of flight, the rocket became unstable and fell to the ground about 1,300 meters from the launch site, bounced back up and got stuck in a tree - the proximity fuse did not fire. So ended the story of one of the most interesting ideas of Prof.

Osenberg

The next project document describes the witch's *cauldron,* ie the work on coal aerosol charges - an excellent addition to the description in one of the earlier chapters. It is a report of a conversation with a certain engineer Lang about the progress of the work. It proposes that these be carried out with high priority, as only then could concrete results be achieved in a short time. It is stated that the success requires a further intensification of the scientific research work. Since the document is dated February 17, 1945, it is obvious that the Germans did not have a chance to put this discovery into practical use before the end of the war.

However, this letter confirms that the Reich Research Council was intensively involved in the realization of the *witches' cauldron project ,* which is so little known today. The printed organization chart for this project is attached to the document. Similarly, document R10 of February 9, 1945 documents the "Council's" commitment to research into combating enemy bombers by jamming their engines, navigational and radio equipment.

R11 is probably the most interesting document printed here. It is an excerpt from a comprehensive collection of reports relating to information about new German weapons that arose on the other side of the front (e.g. through publication). The defense - the

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military intelligence - regularly provided the "Council" with such data.

The reproduced page contains two messages of interest: J-9180 and J-9181. They deserve to be reproduced in their entirety. Here is the content of the first report from December 7, 1944:

> Allied aviators on the Italian front have encountered a new German secret weapon designed to render bombing impossible by crippling the attacking bomber planes. The new weapon is described as a fantastical 'Ice Air Cart', a fighter jet that spurts out clouds of 'dehydrated frozen air' in front of Allied planes as they conduct bombing raids in formation.
>
> The intent is for the 'frozen air' to mix with the rarefied atmosphere and make the whole area a death trap by causing ice to form on the bomber planes, stopping the controls and forcing the whole plane to spin [sic]."

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R11

001484

J 9179 "Daily Mail" über die steigende deutsche Flugzeugproduktion.
(Daily Mail vom 14.12.1944)

An der Westfront hört man jetzt sehr häufig die Befürchtung, daß sowohl die Front wie London demnächst auch bei Tage von Raketenflugzeugen beschossen werden würden.
Die Zahl der an der Westfront erscheinenden deutschen Raketenflugzeuge sei im Steigen begriffen. Man höre, daß die deutsche Flugzeugindustrie immer noch in der Lage sei, bis zu 1500 Kriegsflugzeuge im Monat herzustellen und das werde eine sehr starke Belastung der englischen Offensive bedeutem.

J 9180 "Eisluftwagen" lähmt Bomber.
(Neue deutsche Geheimwaffe.
(Aftonbladet vom 7.12.1944)

Alliierte Flieger an der italienischen Front sind auf eine neue deutsche Geheimwaffe gestoßen, die bezweckt, Bombenangriffe dadurch unmöglich zu machen, daß die angreifenden Bombenflugzeuge gelähmt werden. Die neue Waffe wird als ein phantastischer "Eisluftwagen" beschrieben, ein Jagdflugzeug, das Wolken von "dehydrierter gefrorener Luft" vor den alliierten Flugzeugen ausspritzt, wenn diese Bombenangriffe in Formationen vornehmen.
Die Absicht besteht darin, daß die "gefrorene Luft" sich mit der verdünnten Atmosphäre vermengt und die ganze Umgebung dadurch zu einer Todesfalle macht, daß sie Eisbildung überall auf den Bombenflugzeugen verursacht, die Kontrollapparate stoppt und das ganze Flugzeug zum Spinnen zwingt.

J 9181 Neue deutsche Waffe.
(Interradio Sonderdienst vom 13.12.1944)

Es wird mitgeteilt, daß an der Westfront heute eigenartige Silberkugeln, die durch die Luft flogen, gesichtet worden sind. Man nimmt an, daß die Deutschen eine neue Geheimwaffe anwenden, während es noch nicht möglich war zu ermitteln, wie diese neue.... Geheimwaffe arbeitet. Die neue Waffe wird wahrscheinlich der .... der ernsten Verteidigung sein.

- 6 -

The above information is consistent with reports from Allied intelligence services, with the one exception that the main agent was not "frozen air" but a special mixture of gases that produced a very low temperature as it expanded. Confirmation of another weapon mentioned in report J-9181 is also found in other sources (the information comes from the German

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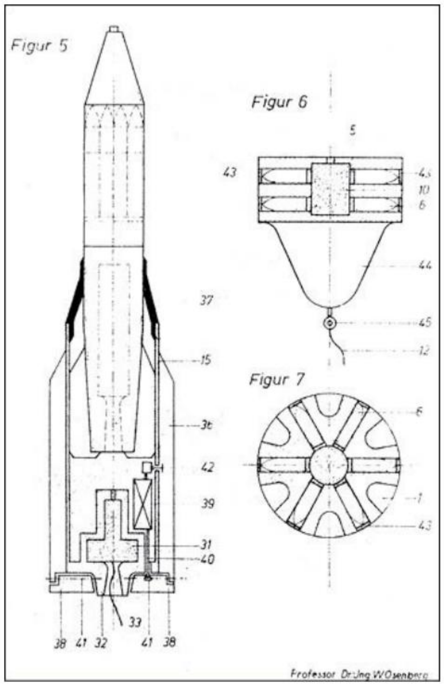
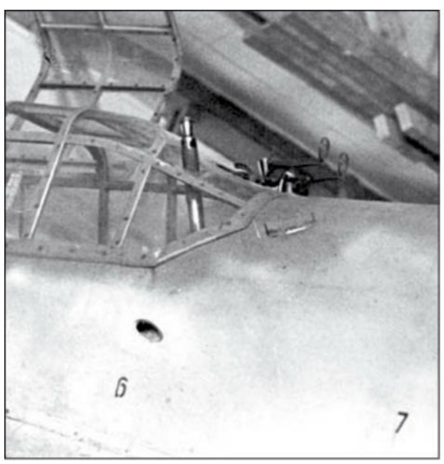
radio interception measures):



One of the unusual concepts of Prof. Osenberg - the project of a two-stage rocket projectile, which in turn should fire smaller projectiles. (Photo: ALSOS)



Weird music - the barrel of the upward-firing cannon. (Photo: NARA)

“It is reported that strange silver bullets flying through the air have been sighted on the western front today. The Germans are believed to be using a new secret weapon while it has not yet been possible to determine how this new secret weapon works. The new weapon will probably be the... [sic]

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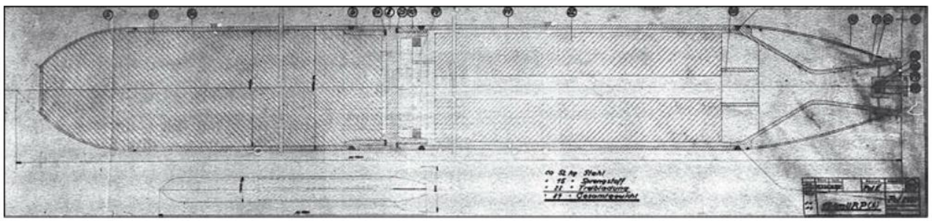
be of serious defence."

A particularly large number of innovative ideas of this kind were implemented in the field of anti-aircraft weapons, where the pressure of technical progress was extremely great. One of the most important, but at the same time least known measures was the coupling of anti-aircraft guns with radar devices, which led to the construction of a fire control system based on radiolocation.

This solution worked extremely well. One of the Allied pilots recalled this: 97



One of the numerous German responses to the Soviet Katyusha project. (Photo: ALSOS)

"This was my second combat flight. I couldn't forget the old fighter pilots' quip: 'They usually shoot your butt off the second time around'. We were over the target. The first shells exploded precisely between the machines. This wasn't a barrage. The latest radio-guided 105 mm guns fired. […]

A huge explosion cloud bloomed right in front of us. We dove into her and felt the rumble of shrapnel hacking through the hull. I saw a shell hit the lead bomber directly. The sides of the hit fortress expanded like a balloon.
The hull miraculously returned to its original form, but large portions fell off and tongues of fire poked out from the slashed seams. The burning machine began to drift to the left."

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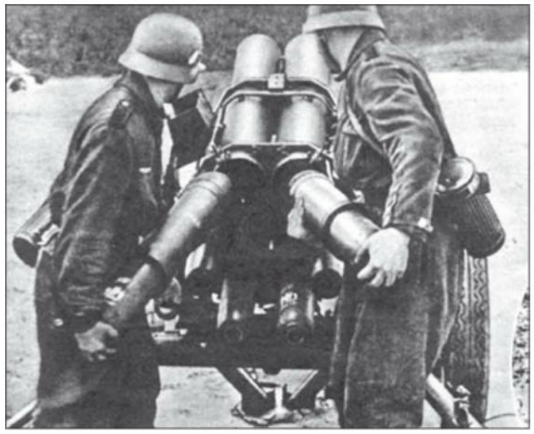

Rocket artillery played an important role in the German army, with the WGr system shown being the most important. (Photo: *The Wehrmacht)*

A WGr missile salvo. (Photo: *The Wehrmacht)*

Another ingenious solution was used for fighter armament. German aviators eventually found that it is very difficult to spot a formation of enemy bombers when flying directly under them - especially at night. They therefore came up with the idea of mounting 20mm cannons perpendicular to the axis of the fuselage on the Bf-110 fighters (behind the cockpit) so that they could fire upwards. Incidentally, this made it easier to hit the bomber, since its silhouette had a much larger area than e.g. B. when attacking from behind. This armament got the unofficial alias *Weird Music.* It was used in conjunction with new airborne radars (SN-2 *Lichtenstein)* which were less sensitive to jamming and the metal foil strips scattered by Allied bombers.

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The debut of this combination coincided with the air raid on Nuremberg (March 30, 1944). Altogether the Allies lost 95 of the 795 bombers that night and the Germans only a few night fighters.

New generation handguns

The concepts described in this chapter were mostly purely experimental in nature and not always superior to existing designs - which is an inevitable "by-product" of any research. Of course, that wasn't always the case - only research makes it possible to find groundbreaking solutions. I would like to present such a weapon below. 80,81 The Germans during WWII implemented many "historical" types of armament that were already well known. The top spot is taken by the MG-42 machine gun, which many consider to be the perfect handgun in its class (although the crucial step, i.e. the roller locking system, was “taken” from Engineer Szteke’s pre-war Polish patent, which he developed for his semi-automatic rifle). The 7.62 mm caliber MG-42 is still manufactured in several countries under different designations (MG-2, MG-3) and is used by several dozen armies around the world. The Walther PP and PPK pistols, which are still popular today, were very successful. The FG-42 automatic rifle was also an original, successful construction, which was specially developed for paratrooper troops. An advanced weapon was the caseless ammunition pistol already mentioned.

However, I would now like to turn to a slightly different handgun, which in my opinion was just as groundbreaking but less well-known: the MP-43 carbine, thanks to which (in view of the increasingly scarce raw materials) completely new technological standards were introduced, which a represent a real qualitative breakthrough. Since it was mainly manufactured using the forging and pressing process, it used far less material and energy than the earlier models, which were mainly manufactured using the machining process.
He gave the soldier a qualitatively new firepower. Let's begin

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but back to the origins...

In the interwar period, infantry armament in almost every country in the world consisted mainly of bolt-action rifles. Based on the experience gained during World War I (a trench warfare), such a solution was considered optimal for several reasons. The advantages of rifles included high accuracy, range and bullet penetration, but their disadvantage was their low rate of fire. This type of armament was therefore well suited for low-intensity battles, when long-term shelling was carried out at a distance of several hundred meters.

To complement rifles, submachine guns were gradually introduced - light automatic weapons that increased infantry firepower when attacking (when they lacked the opportunity for accurate aim) and were also more useful in close-ranged combat. The rifle plus submachine gun combination seemed advantageous. However, after analyzing the first clashes of World War II, the opposite conclusion was reached. This became especially clear after the German invasion of the USSR. On the Eastern Front, infantry used handguns mainly at ranges of 100-200 meters. In such conditions, neither the long range of rifles nor high bullet penetration was necessary. On the one hand, the potential of this weapon remained largely untapped, on the other hand, it was actually low anyway due to the low rate of fire. In addition, the distance of 100-200 meters was too great for submachine guns. Their effectiveness at such distances was very small. Post-war analyzes showed that for every dead or wounded German soldier there were around 40,000 spent PPS and PPSh submachine gun cartridges. It was similar with the German models MP-38, MP-40 and Bergmann machine guns. At such ranges, pistol rounds just weren't effective enough - hitting a helmet didn't always mean the round penetrated it, and a direct hit didn't always disqualify a soldier from further combat.

This problem was particularly glaring for the German commanders, since the enemy usually outnumbered them. The needs formulated after the analysis of the military requirements led to the

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Development of a new type of handgun - the so-called carbine, which –, combined certain properties of a submachine gun (rate of fire) and a rifle (effective range of fire). Since it was assumed that the key element on which the characteristics and design of the new weapon will depend was the cartridge, the Germans initially focused on its development. This resulted in a shortened version of the Mauser 7.92x57mm rifle cartridge.

Cartridges of this type are now referred to as middle cartridges. It should be noted here that the Germans were not the first to develop such a cartridge: this was achieved in 1892 by the Czech ballistician Karel Krnka, who was to make a corresponding cartridge for the rifle developed by the Swiss gunsmith FW Hebler. The rifle was a third shorter and lighter than the Swiss Army rifle of the time. However, their work soon fell into oblivion. In 1918, the German Oberleutnant Piderit published a draft that included a project to put into production a cartridge similar to the Czech one. In 1927 a 7 mm medium cartridge was developed by the Mauser company and manufactured in small numbers. In the 1930s, various production facilities were working on a handgun for these cartridges.

The Walther company was the first to register their prototype for trials in 1938. After numerous modifications, the weapon received the marking MKb-42(W) – Maschinenkarabiner-42. Since then, the name "carbine" (English: carbine) is used. Although the MKb-42(W) was not tested further (to later appear under a different designation in a version adapted for new cartridges), research work on the new cartridge was suspended due to an official Army order dated April 18 continued in 1938. Despite a 50% reduction in the mass of the primer (compared to a rifle cartridge), the effective firing range of the weapons chambered for this cartridge was significantly greater than that of submachine guns chambered for the 9mm Parabellum cartridge. The 7.92 x 33 mm short cartridge in the version approved for production was developed by the GECO company between 1934 and 1938. It was the first medium cartridge in history to enter the arsenal of weapons. Their production began a year after the outbreak of war in two versions: with a lead and mild steel core.

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	parabellum 9 mm	Short cartridge	moult rifle cartridge
Cartridge weight (g)	10.5 - 12.5	16.5 - 16.8	24.1 - 26.2
Bullet mass (g)	7 – 8	7.9 – 8.2	11.53 – 12.83
Mass of ignition charge (g)	0.32 - 0.36	1.57 - 1.59	3.15 - 3.25
Cartridge length (mm)	29.7	47.8	80.5
Sleeve length (mm)	19	33	56.8
Bullet length (mm)	15.5	25.6	28
Muzzle Velocity (m/s)	390 - 400	690 - 700	765 - 911
bullet initial energy (J)	580-590	1,880 – 2,010	3,374 - 5,324

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The second of the new carbines, the Haenel MKb-42(H) was developed for the new GECO cartridge. The main designer of the MKb-42(H) was the famous Hugo Schmeisser, which certainly contributed to the fact that this design proved better than the MKb-42(W). However, both models worked on the same principle: the automatics were powered by the partial use of powder gases, which were discharged through a side opening in the barrel. Similar to most modern carbines, the gas line was located above the barrel. Locking was via a break-barrel breech. The heavy weight of the weapon and the high complexity compared to a submachine gun were unavoidable due to the large muzzle energy of the projectile - which made it necessary to lock the barrel when firing - as well as the large recoil force and high temperature of the powder gases; because of the last two points, the gun had to be built very solidly (so that the barrel overheated less).

Comparison of the three main types of cartridges used by German infantry. Left to right:

1) Parabellum 9 mm - for pistols and submachine guns (e.g. MP-40)

2) Short cartridge - medium cartridge for the MP-43

3) Mauser rifle cartridge

(Photo: I. Witkowski)

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Initially, the MKb-42(W) and MKb-42(H) were produced in small numbers and subjected to comparative studies on the Eastern Front. They were parachuted into an encircled and cut off supply infantry unit who managed to escape the encirclement and then gave their opinion on both types of carbines. It was clear from this that Haenel's design was better. Haenel then received a pre-order for 8,000 pieces of this weapon, the designation of which had since been changed to MK-43. The order was completed in a record time of three months.

Elite units, mainly the Waffen SS, were equipped with the MK-43. After that, production was halted for a period due to the high cost of production, which was higher than the MP-40. Of course, the merits of this pioneering type of weapon, such as the carbine, were not as obvious then as they are today. However, after analyzing the reports from the front, which came from users of the MK 43, the arguments of the skeptics were refuted and production resumed, this time on a large scale.

In order to standardize the naming of infantry handguns, a new designation was introduced: MP-43; it was soon changed to MP-44. Since the carbine was not a submachine gun, as the acronym suggested, the weapon eventually received the designation StG-44 (Assault Rifle, Model 44). In practice, all designations were used alternately, with MP-43 being the most common
was.

The infantry equipped with the MP-43 had much greater firepower at their disposal and could use different tactics. The short cartridge made the gun very accurate, and the bullet had a much greater killing potential. Despite being an automatic weapon, the weapon could easily be operated by a single soldier. The bullet had three times the kinetic energy of the 9mm Parabellum for the MP-40. Fire could also be opened in the barrel during an attack without the need to brace the butt on the shoulder. Most of the manufactured carbines were equipped with an attachment for firing anti-infantry shells.

Experiments with curved barrel ends were also carried out

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mounted on modified versions of this weapon. A barrel end could be mounted on the StG-44V, which made it possible to fire at an angle of 30° - 40° in relation to the main axis of the weapon. The StG 44P had a barrel end for firing at a 90° angle. Both devices bore the name *Krummlauf* and were equipped with additional sights. However, during the trials it turned out that the concept was flawed and did not promise good results. Line units were probably not equipped with the two constructions mentioned, so they were probably not used in combat.

A German Ski Division soldier armed with the MP-43, early 1944. (Photo: CAW)

The MG-42. (Photo: *The Wehrmacht)*

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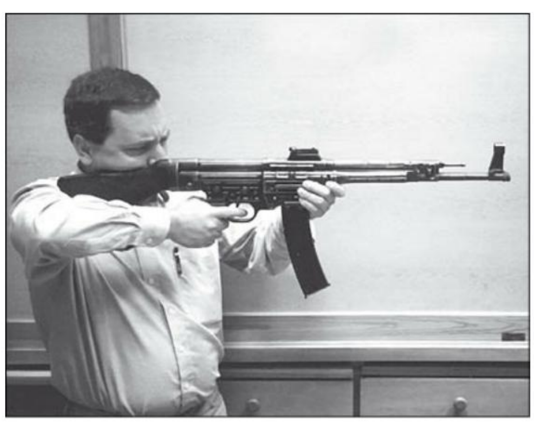
The submachine gun MP-40. (Photo: I. Witkowski)

To the extent that the Germans gained experience with the MP-43, their construction was systematically improved: Many specimens had, among other things, the possibility of mounting optical sights, and from the beginning of 1945 also night vision sights (!), which worked in the near infrared and the name Aim 1229 *Vampire* obtained. At the end of the war, a few modernized versions were developed: the MP-45(M), the "Device 06-H" and the StG-45(M). The MP-43 retained its advantages, but its design was simplified somewhat to reduce manufacturing costs.

Work on the StG-45(M) was the most advanced. It was equipped with a two-piece roller-locking breech. Shortly before the end of the war, the design team and the existing prototypes were evacuated to Spain, where the work was completed.

The result was the design of the CETME-58 carbine, which is still used in the Spanish army to this day, as well as the G-3 rifle, manufactured by Heckler and Koch and licensed in 15 countries and used by armed forces in about 50 countries will.

The submachine gun MP-43. (Photo: I. Witkowski)



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The weapon family designed for the short cartridge was characterized by a sophisticated design concept. The MP-43 was highly valued by Allied soldiers as a captured weapon. The carbines captured by the Red Army were handed over to the GDR People's Police as armament; ammunition production was therefore continued after the end of the war.
These weapons served for many years until they were replaced by the Kalashnikov. In Finland, the Suomi carbine was developed, which was based directly on the StG-44. The cartridges were almost the same, although the caliber was reduced to 7.62mm. The groundbreaking design of the MP-43 underlies all modern carbines and rifles, such as the B. the AK-47, the FN FAL and the L1-A1.

The MP-43 enjoyed growing popularity among soldiers, because accuracy was not the only important thing for them. The gun weighed almost exactly the same as the German MP-40 main submachine gun (4.7 kg / loaded: 4.9 kg). In contrast to the weak pistol ammunition, a projectile fired from the MP-43 still penetrated any helmet of the time at a distance of 600 m. Thanks to technological progress, a copy in 1944 now cost only 70 Reichsmarks.

The exact number of copies made is not known, we know however, that there were at least 425,000 pieces by the end of the war.[80]

In the introduction I already quoted from the "Weissenborn Report", which contains statements by the former deputy head of the Weapons Office in the Speer Ministry. Weissenborn, in whose opinion the MP-43 was the best infantry handgun in the world, left a lot of information about the still little-known aspects of its manufacture: "In the spring of 1943, the then Colonel Kittel, head of the weapons research department of the Army Weapons Office, gave a lecture on

> the automatic Carbine, model 43, for so-called middle cartridges. The lecture took place in the technical department of the Speer Ministry, and the audience came from the inner circle around Hauptdienstleiter Saur, the head of that department. While retaining the standard German caliber of 7.92mm, the automatic carbine represented a significant improvement over the

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Submachine gun MP-40. This pistol used by the German army was chambered for 9mm pistol ammunition and its effective range of fire did not exceed 150 m. The magazine attachment was extremely unsatisfactory. If the magazine was moved during firing, this would lead to unstable firing. Apart from that, the MP-40 reacted very sensitively to dirt.

In contrast, the Model 43 automatic carbine was accurate at a range of up to 600 yards; its 30-round magazine was rigidly attached. It was less sensitive to dirt and was suitable for single and continuous fire with center cartridges - a shortened version of the standard rifle cartridge.

Based on personal experience on the Eastern Front and many conversations with regiment leaders, Colonel Kittel became convinced that only the introduction of this weapon could stop the new Soviet offensive:

'In a situation where there are no opportunities to reinforce the Eastern Front, the combat effectiveness of each and every German soldier must be increased at all costs through the introduction of a handgun with a higher rate of fire.' The specialists in the field of rifle manufacture involved in the discussion had no doubt that the automatic carbine represented a great advance, and they wholeheartedly agreed with Colonel Kittel. Nevertheless, the rapid introduction of the new weapon was neither technically possible nor was there any approval from above, since an order from the Führer's headquarters demanded the cessation of the production that had started, while another order stopped any discussion of the MP-43 during the briefing at the Führer's headquarters (FHQ) banned. What's more, a short time later the Main Weapons Committee, as the body in charge of the armaments industry, received orders from Hitler to cease production of the carbine immediately, while the MP-40, which was well known for its disadvantages, was manufactured at the same pace as before should be, ie about 15,000 pieces per month.

However, the Main Weapons Committee did not carry out this Führer order

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and even increased production to 5,000 a month by classifying the carbine as a submachine gun (later renamed the 'Sturmwaffe-44' / StG-44). Both the head of the Department of Weapons and Armaments in the Army Weapons Office and his party comrade Saur from the Speer Ministry demanded that the Führer's order be carried out. However, at the insistence of Colonel Kittel and the officers from the line units, the Main Weapons Committee also persisted in its cause and maintained the production of around 5,000 pieces a month. This led to a discussion with Hitler. Two soldiers who were awarded the Knight's Cross on the Eastern Front were also involved. Eventually Hitler issued a new order calling for the immediate production of 30,000 carbines a month. A few weeks later he was already asking for 50,000 pieces, after a few months 90,000 and soon even 120,000 a month. Before that happened, however, the industry's potential had been wasted for over a year. […]

A consequence of the lack of planning and engineering guidance was the growing shortage of medium ammunition for the MP-43, which was growing month by month. The replenishment of normal small arms ammunition was also insufficient, which was partly due to the increased manufacture of carbines. This soon led to the halting of mass production of the MP-43, which had been laboriously ramped up to 50,000 a month.

Many thousands of copies of this weapon, which had been tirelessly manufactured day and night, had to be scrapped, although the front-line units begged for each copy. At the same time, Allied bombers leveled a factory in Poznaÿ that made machines for the production of small arms ammunition. [...]"

infrared technology

A classic example of the search for solutions to problems, which ultimately led to the development of a completely new technical area, was the question of infrared technology. Interesting results were recorded in this area even before the war, the prerequisites for rapid development

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However, this technique only emerged during the war. One of the most important impulses was the effort to create an alternative to the radar device. In this area the Allies had a slight superiority.

It is not the first time that radically new technologies have emerged merely as a replacement for already existing solutions. The new production technologies used on the MP-43 were also introduced out of necessity rather than consideration. Plastics were also largely viewed as a stopgap measure ...

However, let's return to infrared technology. I don't want to describe all types because there were a lot of them. Therefore, I present this complex in an abbreviated form. Infrared devices can generally be divided into three groups:

1. Night vision devices as "active" observation and targeting devices. They require illuminating the target/area with infrared rays emitted by a special searchlight;
2. Thermal direction finders and thermal imaging devices (“passive”). The target does not have to be illuminated, the devices simply receive the thermal radiation generated by the target itself; 3. Heat detectors as elements of homing warheads for bombs and missiles. They are described in the second part of the book.

The main group was made up of the devices mentioned under point 1. There were about a dozen different types of which I will describe a selection below. 64,82,83,84 Most German night vision devices were based on image

converters (photomultipliers) developed by the Reichspostforschungsinstitut and manufactured in small numbers. His laboratories were initially in Berlin, but due to the threat of air raids they were moved to Hassenbach.

The devices manufactured there were in no way inferior to their many post-war counterparts from the 1960s and 1970s. The principle of operation, of course, remained the same, and the design characteristics did not change either. The following description of a 1984 night vision converter could apply equally to the 1940s devices:

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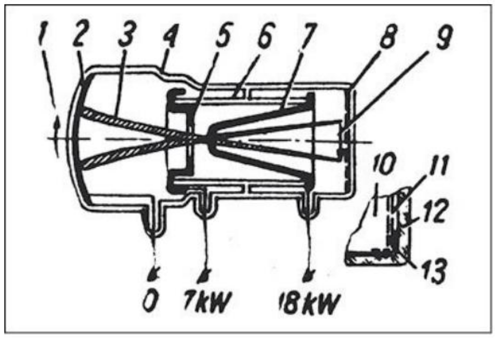

Cross-section of a typical imager; a brief description can be found in the text.
(Photo: CIOS)

“The heart of every active night vision device is an electron-optical image converter (Figure 1). The infrared image of the observed object is focused on its photocathode (2). The typical photocathode with a coating of silver-laced cesium oxide used in the converters of these devices is a receiver of short-wavelength infrared radiation in the wavelength range between 800 and 1200 ÿm. The infrared rays falling on the photocathode lead to the emission of electrons, which - accelerated and focused by the electrostatic field generated inside the converter tube - generate an electronic image (9) of the object on a screen (8) coated with an appropriate phosphor. Under the action of the electron beams, the screen emits visible radiation, which can be observed through the eyepiece of the night vision device.

The picture shows the typical construction of an active night vision device in cross section. The complex multi-lens lens with large relative aperture is particularly striking here.
This construction is necessary because as many beams of rays as possible have to be collected on the photocathode in order to generate a good quality image and to achieve the maximum visibility.”

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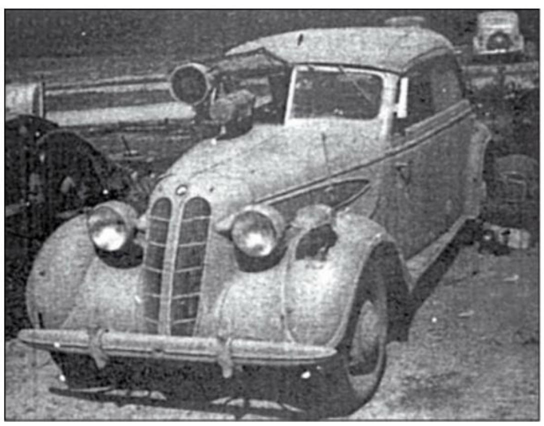
The Uhu system on a half-track reconnaissance vehicle. (Photo: CIOS)



The FG 12/52 mounted on a BMW passenger car. (Photo: CIOS)

The devices manufactured by the Reichspostforschungsinstitut also had infrared-sensitive coatings of cesium oxide mixed with silver, which were vacuum-evaporated by the evaporation of a hot coil. Outwardly, the whole transducer resembled a large electron tube. Its anode, ie the layer visible through the eyepiece onto which the image was projected, received a green coating

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luminous luminophore composed of a mixture of zinc sulfide and zinc selenium. Two main types of transducers were produced: 160mm diameter (600-700 pieces a year) and 70mm (over 200 pieces a year). All the work was carried out with relatively modest resources – the Hassenbach laboratory employed only 40 scientists and technicians.

The second manufacturer of these devices was the AEG company, which produced 400 image converters with dimensions similar to those mentioned above. However, only 186 passed the quality test with a positive result (image quality was examined). It was found that 78 pieces were suitable for the production of sighting devices, the rest were supposed to be used in various observation devices - mainly for drivers. The AEG company was a global pioneer in this field - the first image converter was tested there as early as 1934!

The abbreviation "Biwa" was often used for image converters.

Now we come to the descriptions of some models of the night vision devices constructed in the Third Reich.

Zielgerät ZG 1221

This target device was intended for anti-tank guns and used a converter from AEG. The optical elements were manufactured by the Zeiss company (including 1,000 lenses). The markings visible on the scope indicate that it was factory set for a firing distance of 250m.

The sharpness was adjusted by the electrostatic focusing of the electron beam. An integral part of the system was an infrared illuminator with a diameter of 36 cm, which served to illuminate the target. Several hundred copies of a test series were delivered to ground forces so that they could carry out tests; after that the work was interrupted. There is no data on whether the device was eventually used in combat.

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The MP-43 with the *Vampire* night vision sight (weapon without magazine) (Photo: CIOS)

Target device vampire

The *vampire* is one of the most interesting German devices from the group described. This sight was intended for MP-43 / MP-44 automatic carbines. The night vision scope itself was dimensionally comparable to the larger optical sights: about 35 cm long and just over 6 cm in diameter, and weighed with the small infrared illuminator (a 35 watt lamp covered with a filter) only 2.3 kg.

The backpack set, which consisted of a battery and a high-voltage converter, was heavier and weighed almost 14 kg - this hurdle could not be overcome long after the war. The heavy weight was not solely due to the power consumption, but to the need to convert the battery voltage to high voltage - in this case 11 kV to be able to power the imager.

This device entered the arsenal in small numbers and performed surprisingly well. Although it was a bit too heavy for the soldiers in the first line, it was an ideal invention for guards. In these conditions, it was not a problem that the battery only lasted for three to five hours of continuous operation, as they are quickly replaced could. The manufacturer of the *vampire* was the Leitz company, which used the small "post converters" - a total of 300 complete sets were supplied.

After the war, the British tested a specimen of the *vampire* and concluded that the image was "very bright and contrasting." The summary of the research results reads as follows:

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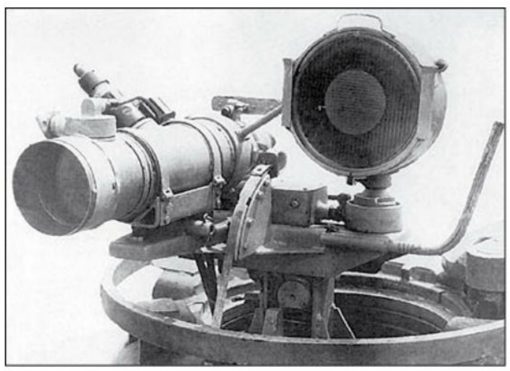
> “At a distance of 30 meters, silhouettes of standing and lying people were clearly visible; at a distance of 50 meters only standing people were clearly visible, whereas lying down people were difficult to distinguish from the background; at a distance of 80 meters it was difficult to see standing people, especially when they were moving”.

Many of the approaches incorporated into the *Vampire* were the starting point for similar work undertaken in other countries after the war, with the Russians fully copying this set of equipment and thereafter incorporating it into the arsenal of their own army and the armies of other members of the Warsaw Pact.



The FG 12/50 on the turret of the Panzerkampfwagen *Panther.* (Photo: CIOS)

Eagle I and Eagle II

Based on solutions that have proven themselves within the framework of the *Uhu* ground system , comparable anti-aircraft solutions were developed as a kind of counterpart to the short-range radar device.

Small changes were made to the optics – the focal length was reduced from 40 to 25 cm, which resulted in an increase in the field of view, and two eyepieces (of the same type as binoculars) were used instead of one. More than 500 such optical systems were made, although this device was never included in the arsenal of weapons. The radar device was able to assert itself here, since the present solution could not determine the distance to the target, although the effective range (according to German sources) was exceptionally large and was around 25 km. However, it was not specified to which

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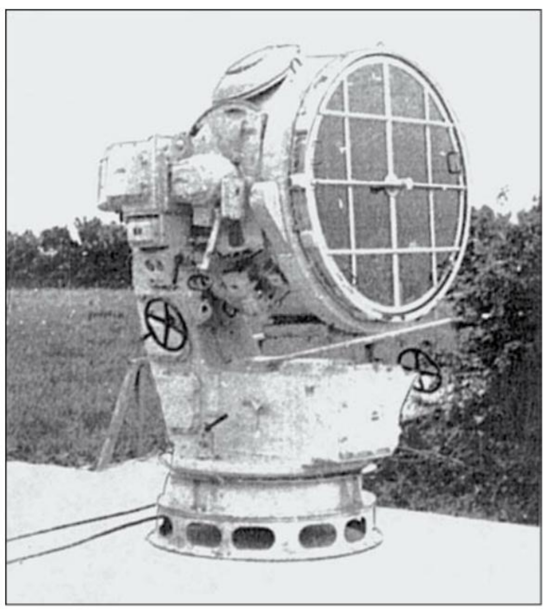
Aircraft type this information referred to, although it can be assumed that they were large bombers.

seal

The *Seehund* is one of the most interesting and best German night vision devices. It was developed for the Kriegsmarine at the beginning of the war in Vendome, France, where American officers found one of these devices and its operating instructions, which were dated "October 1941".

This night vision device was intended to be installed on ships (although it was basically a portable device). Its main purpose was probably tracking foreign aircraft at night. Here again we are dealing with an attempt to develop an alternative to the radar device - although the Germans had important successes in this area as well.



Large 1.5 meter diameter infrared illuminator used in the Navy. (Photo: CIOS)

The night vision device (receiver) itself weighed 11 kg and was to be powered by the ship's installation through a 15-meter cable and a stationary voltage converter weighing 20 kg.
Various infrared illuminators could be used in the device: a

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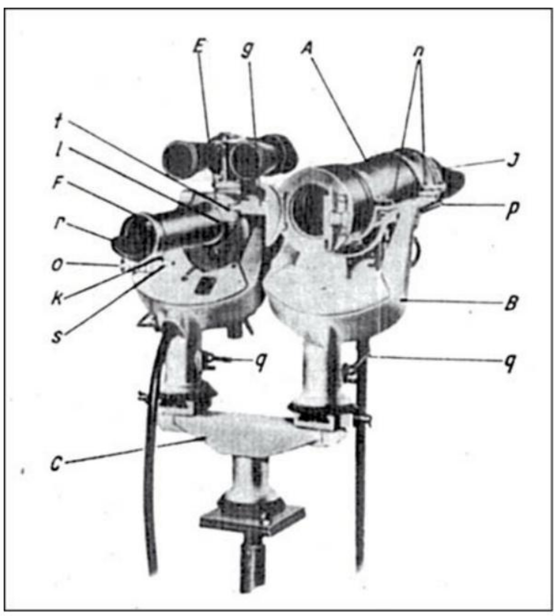
portable that could detect targets at a range of 10 km, one with a diameter of 50 cm that doubled the range, or a large one with a diameter of five feet that increased the range to infinity, the original instruction manual said: "up to the [illegible] American report on the *seal states* that the Goertz company was probably heavily involved in its development.

Before the war, this company, along with Siemens, was a pioneer in the field of television [illegible] position of the Third Reich in this field was the main reason for the subsequent rapid development of night vision and thermal imaging devices. In fact, the basic operating principle of an image converter in night vision devices, i.e. the formation of the image due to the electrostatic or electromagnetic focusing of the electron beam, is exactly the same as in the case of the electron microscope.



The *seal.* (Photo: CIOS)

However, let us return to the *seal* ...

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In the investigation report on the “intercepted” specimen, the Americans described it almost exclusively in superlatives: simple operation, resistance to adverse conditions (especially water resistance), good resolution, large field of view (22°), high sensitivity and opacity of the filter mounted on the lens to visible light. The only shortcoming was the inability to quickly replace the image converter - this process took about an hour and required a specialist. The *Seehund* was equipped with a modified imager with a beryllium cathode, which made it possible to achieve much higher contrast than before, which was desirable in the case of detecting air targets. It was probably the AEG converter with a diameter of approx. 75 mm. One of the development versions of this night vision device was the *Seehund III,* which was intended for submarines (radar devices for locating air targets were only intended for Type XXI submarines). In May 1943, 1,250 of these devices were ordered, although only about 400 were eventually delivered.

The *Seehund III* differed significantly from its predecessor – above all, it was smaller. The lens diameter was only 5 cm, which probably had a negative impact on the range. However, he had a larger field of vision.

Spanner

As late as 1941, an attempt was made to construct a passive night vision device (without illuminating headlights) that was supposed to react to the hot engine exhaust fumes of Allied bombers. Night fighters were equipped with these devices, which is why around 600 copies were delivered as early as 1941. However, the concept did not prove itself in combat conditions, and the devices were withdrawn.

The (passive) thermal imaging devices formed a separate group.

Many readers will surely be amazed by the fact that they were based on semiconductor elements. One of the British intelligence reports even mentions attempts using silicon! 89 In the infrared detectors, however, semiconductors of a different kind were used.

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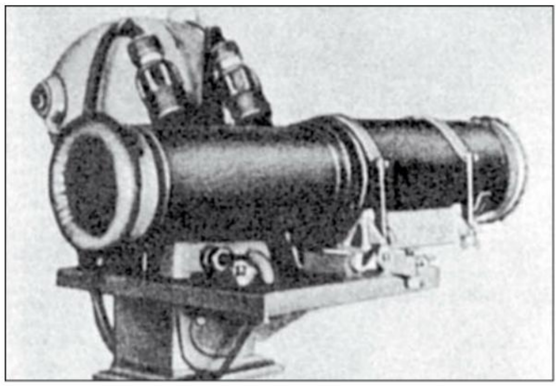
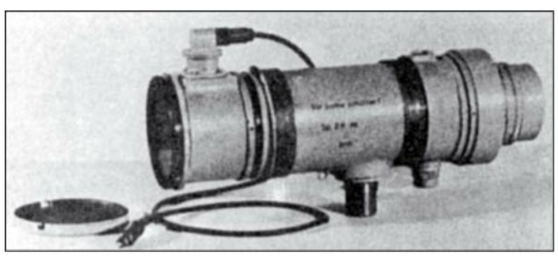
They were sensitive to waves a few microns long, to which night vision goggles' image converters were unresponsive. This wavelength roughly corresponded to the radiated heat from objects that had a temperature of several tens of degrees Celsius.

The functional principle of all German thermal imaging detectors was based on the so-called inner photoelectric effect. It is based on the fact that after the absorption of photons, the semiconductor no longer behaves like an insulator, but like a conductor - the electrons are "lifted" from the valence band to the so-called conduction band.



The *Peeper* I. (Photo: CIOS)



The *tensioner IIA.* (Photo: CIOS)

“Holes” are created in the semiconductor, which conduct the electric current. So the simplest detector consists of a crystal of the appropriate chemical compound and two electrodes. If it is part of an electrical / electronic circuit, when the detector is illuminated with thermal radiation, an electrical impulse is generated, which is reported visibly or acoustically on the monitor.

At present, individual detectors are no longer used in observation and targeting thermal imagers. a certain intermediate stage

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that predominated in the 1980s were array detector systems. Such an array was responsible for one image dimension, while the second image dimension was created through the use of a so-called scanner - a system of rotating mirrors (e.g. a rotating cuboid covered with a reflective layer) through which the detector array captured the Received radiation as if scanning each part of the field of view. To a certain extent, the fax represents a similar device, but in it it is not the object image but the object itself that is drawn past the row of miniature detectors.

The latest generation of thermal imaging devices is built like a video camera - no mechanical scanners are used, but two-dimensional detector systems (which look like integrated circuits). Therefore, one might think that building a thermal imaging device with meaningful image quality is not possible if only a single detector is available. However, this is not the case.

The Germans tried to compensate for this deficiency by using "more sophisticated" scanning systems. In this way, an image quality was achieved that was in no way inferior to the image quality on the monitors of typical radar devices of the time.

Thermal imaging devices were then dominated by the much more advanced radar devices, but the Germans knew full well that their real heyday was yet to come, that the technology behind them was promising and that it was undoubtedly worth investing in the development of this technology.

At least a dozen detector types from the so-called mid-infrared range have been developed. Two companies were commissioned with their development and test production: Elektro-Akustic (Elac) from Kiel and Zeiss-Ikon from Jena - one of the branches of the Zeiss concern, which, by the way, is still a magnate of the thermal imaging device production today.

Among other things, Elac began limited production (1,000 planned per month) of a whole range of detectors based on lead sulphide (PbS) crystals. 90 They reached their greatest sensitivity to waves with a length of 2.5 micrometers, i.e. at the so-called first atmospheric window: the atmosphere does not let through the entire infrared range, but only certain "ranges" - waves with a length of about two to five and eight to twelve microns. there has been a

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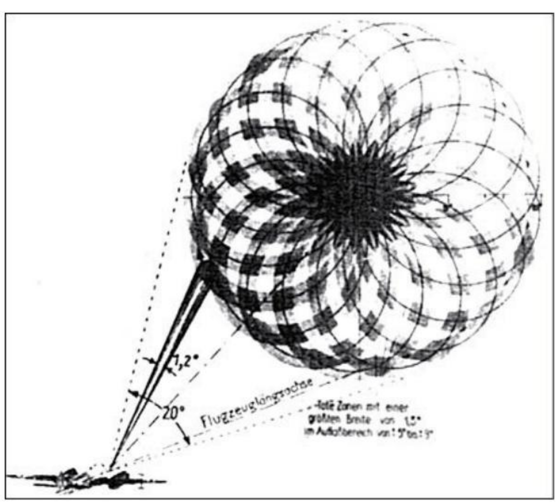
developed a whole series of sensors with dimensions of 3 x 3 mm and also round sensors with a diameter of 30 mm. The larger ones were of course more sensitive, but the finished device had a much lower resolution as a result. In accordance with the theoretical assumptions, the Germans very quickly discovered that the sensitivity of the detector can be increased even fifty times if it is cooled to a temperature of minus 40-50 degrees Celsius. In this way, the thermal radiation generated by the detector itself is eliminated.

Therefore, a special cooler with the alias *Eskimo* was developed, which worked on the basis of carbon dioxide. This resulted in an almost enormous increase in sensitivity for that time - the detector alone (ie without optics for focusing) reacted to radiation with a power of 25 millionths of a watt! [82] By the end of the war, around 500 semiconductor components of this type had been produced in the laboratories of the Elac company alone, and an unspecified number were also manufactured in the factories of the electronics company Kast and Ehringer in Stuttgart.

The latter company also engaged in the production of the second type of detectors developed in the Elac laboratories. Synthetic lead selenide crystals (PbSe) were used here.

They differed from the above solution mainly in that they responded to longer wave infrared (four to five micrometers) emitted by objects with a lower temperature. Their sensitivity was comparable to that of sulfide crystals.



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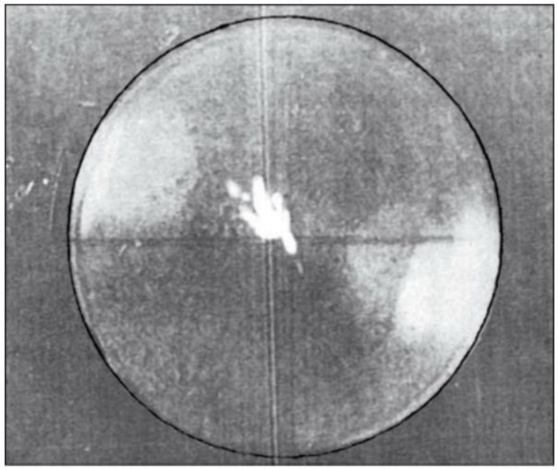
Kiel III - Original diagram from scanning the field of view ... (Photo: CIOS)



... and the image of the target on the screen. (Photo: CIOS)

The key to the Elac company's success in this field was basically one person - the director of its infrared technology department, Dr. Coachman. As early as 1930 he began to develop the optimal technology for the production of sulfide detectors and thereby became a pioneer in the field of semiconductor technologies.

The second leading manufacturer of these devices, the Zeiss-Ikon company, also developed some models, all based on lead sulfide. In general, they did not match the Elac detectors and were mainly used for less demanding systems, e.g. B. in alarm systems that “guarded” the port entrances (the system *radiation barrier),* as well as in devices for clandestine communication between ships; this solution was based on a directional infrared beam (the *Puma system).* However, intensive research was carried out on these devices and their most important parameters were continuously improved. For example, the ratio between sensitivity and noise level is increased twentyfold. Nevertheless, by the end of the war they were slightly inferior to the detectors from Kiel and Stuttgart. The Zeiss laboratories were also experimenting with a newer type of detector based on thallium bromoiodide. It is known that this detector received the KRS-5 designation, but there are no technical data. This complex of questions was also worked on independently at the Physics Institute in Göttingen. On the other hand, Zeiss was able to shine in another equally important area, namely the development of

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optical systems: lenses and relative optical materials (ordinary glass transmits electromagnetic waves from the visible range and e.g. the ultraviolet range, but not from the mid-infrared range, which we can see in a greenhouse or in a vehicle exposed to the sun without air conditioning). Zeiss worked in this area with the IG Farben concern

together.

Finally, eight "types of glass" were developed, which were of course free of the "classic" silicon dioxide. Above all, chemical compounds such as thallium bromide, iodide and chloride as well as silver bromide and chloride were used. At least several hundred kilograms were produced from this "glass" and ground into classic lenses. However, they had certain disadvantages - first of all, they were very expensive and their mechanical and chemical resistance was lower than that of ordinary glass.

For this reason, and also because of the simplified manufacturing process, lenses with a large diameter were mainly used as mirror lenses or mirror lenses. Running mirror lenses. However, in the absence of lenses, filters (mainly interference filters) had to be made of 'special glass'.

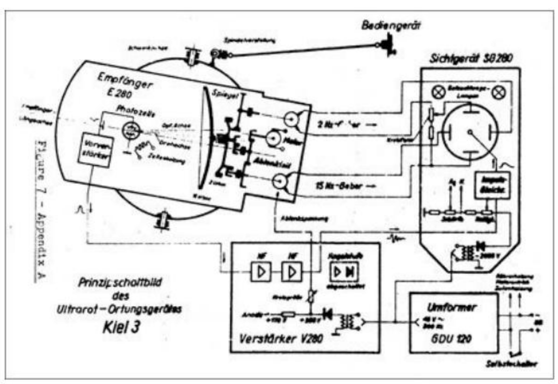

Diagram of the *Kiel* III system. (Photo: CIOS)

At the same time, research work of a similar pioneering character was also carried out in the chemical field. The aim was to develop special camouflage colors for the infrared range in order to prevent detection by night vision devices. Considerable funds were invested in this, although the enemy never began to use night vision devices, anyway

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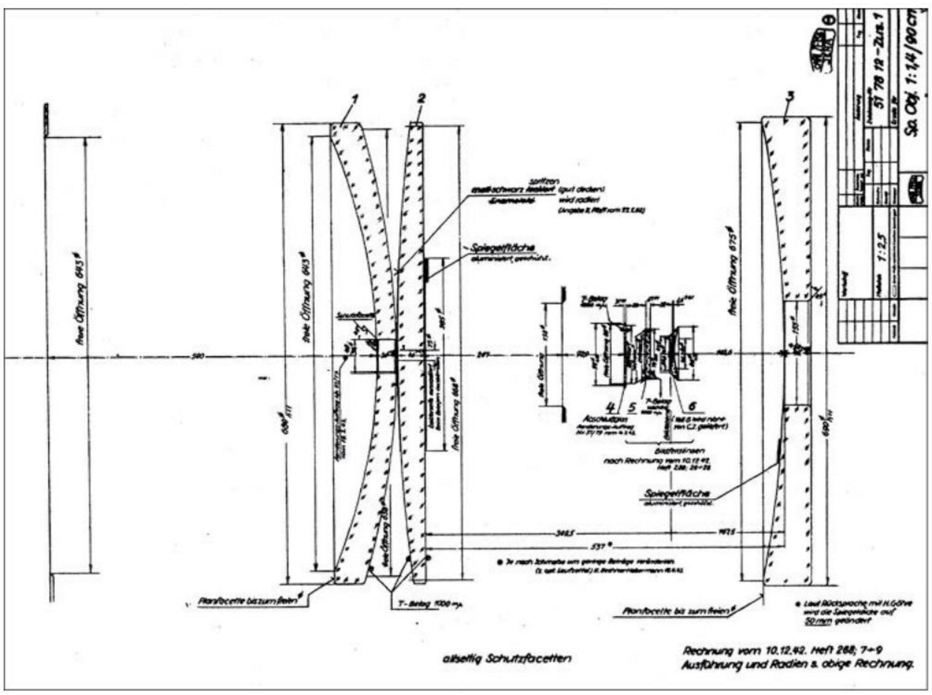
not to a large extent. The companies and institutions cooperating in this field included the Danish companies NVK and CPVA, a special office marked with the letters FEP (research, inventions, patents), which was probably located at the Reich Research Council, and the companies Ludeck and Kohe from Berlin. If we compare that to the total number of companies and institutions that worked on the development of night vision and thermal imaging devices, this list is pretty short. In addition to those already mentioned, there are also the following companies and institutions: the Reich Ministry of Aviation (RLM), the High Command of the Navy (OKM), the companies GEMA, Osram and Stohl, the Institute for Applied Physics at the University of Cologne and the Physics Institutes in Prague and in Leipzig.



The *Kiel III* - one of the head versions. (Photo: CIOS)

However, let's return to the description of camouflage coatings - research in this area was successfully completed as early as 1943. Several types of special colors were developed, among others under the alias *picket fence,* later also *garden fence.*

They absorbed at least 96% of the infrared radiation from the range receivable by night vision devices (wavelength: about one micrometer).

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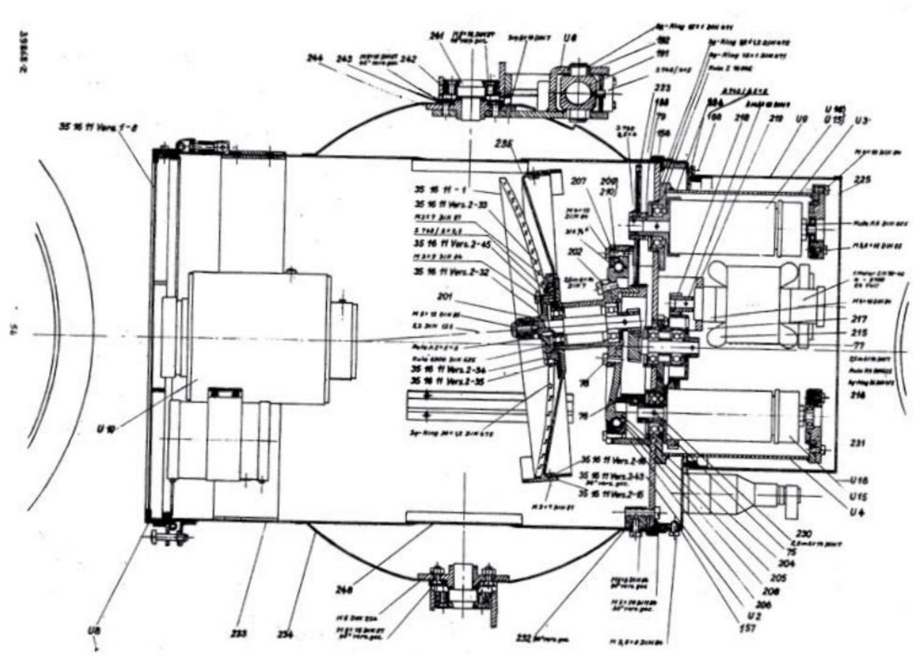
These paints were primarily intended to be used to mask submarines, although over time their lack of seawater resistance proved to be a problem. However, this was of no greater importance, since radar and sonar devices were the main threat to submarines anyway. The Germans did not have time to use the wartime achievements in this field, only decades later the correctness of the implemented solutions was revealed.



The *Kiel III* - cross-section of the infrared telescope. Although this is just one of many system components, reflecting only a fraction of the work in this field, it shows how much has been invested in the development of infrared technology. (Photo: CIOS)

With that introduction, we can now move on to describing specific thermal imaging systems…

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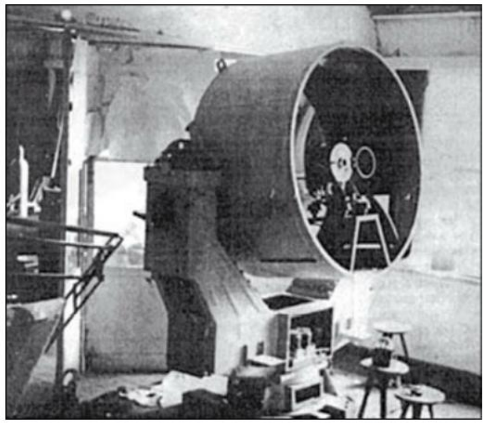
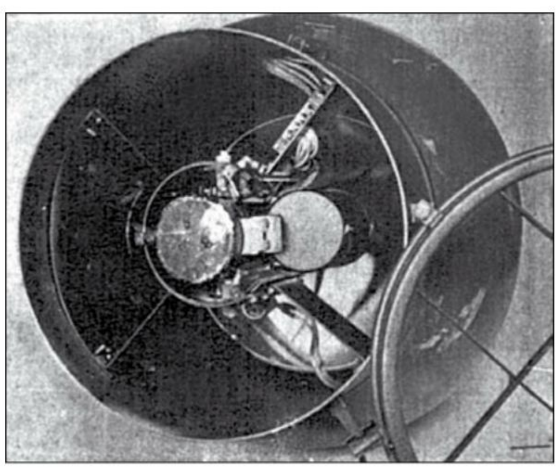


The WPG head. (Photo: CIOS)

The Germans themselves considered the heat detector, named *Kiel ,* to be their most useful and best device from this group. It was designed for night fighters so they could spot enemy bombers - in other words, it was used for target detection. This was done passively and was insensitive to the interference that radar devices were exposed to, which were being emitted more and more frequently.

The *keel* detected a single four-engine Lancaster bomber at a range of 4-5 km. Conducted tests proved its usefulness in other applications as well – small ships with a water displacement of 1,500 tons were “noticed” at a distance of 7 km, and factory chimneys at a distance of 10 km.



View of the optical system after removing the infrared filter - *Kiel.* (Photo: CIOS)

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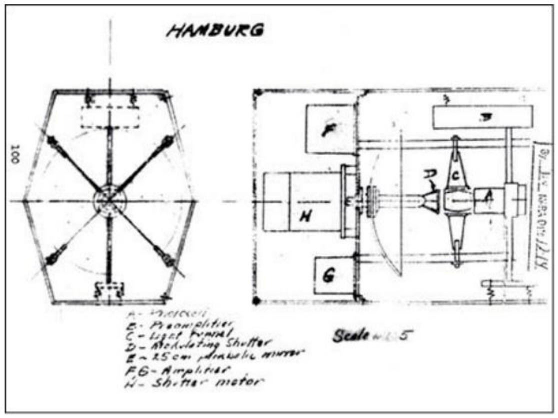

The Hamburg system. (Photo: CIOS)

The *keel* had a relatively light and short mirror lens, a parabolic mirror with a diameter of 23 - 25 cm. To scan the field of view, this mirror rotated at a speed of 100 revolutions per second around the axis of the whole device and at the same time at a speed of two revolutions per second around a second, slightly inclined axis. In this way, the bundled infrared rays in the focal plane described a specific curve (rosette) that covered the entire field of view. Several versions of this system were developed *(Kiel I - Kiel* IV), which differed from each other mainly by the field of view. The most successful version was the *Kiel III,* which featured a field of view of 20° and a resolution of one degree.

There was also a lens-lens version, *Kiel I ,* which was a further development of an older Elac heat finder called the *Kormoran .* However, work was halted fairly quickly due to an avoidable defect: about a third of the radiation was absorbed by the objective lens.

There were also two variants of the *Kiel III* – one used a 3 x 3 mm detector from Elac, while the other *(Kiel III* Z) used a similar detector from Zeiss. Both were cooled with solid carbon dioxide transported in a special container. In the course of the tests carried out by the Luftwaffe's test command at Stade Airport and on the test site in Rechlin, only the *Kiel III Z* could be classified as ready for series production. However, the speed of production was modest. The only batch (approx

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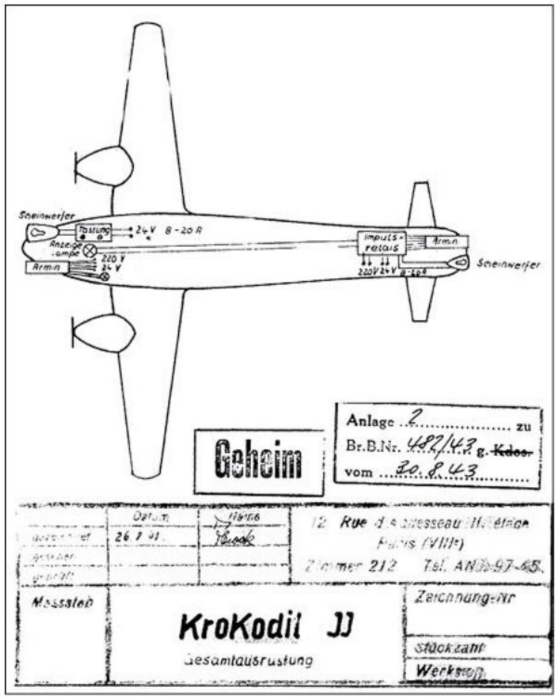
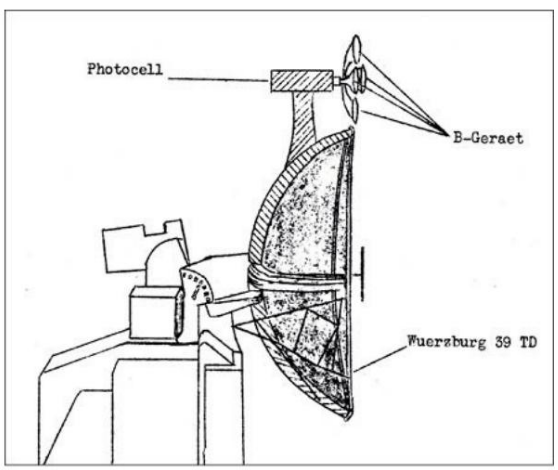
20 – 30 pieces) was given to the night fighter squadron stationed at Goslar Airport around the turn of the year 1944/45. The devices were mounted on the nose cone. 82.90



Scheme for installing the *Armin / Krokodil* thermal target detection system on a night fighter. (Photo: NARA / ALSOS)



Installation of a thermal direction finder on the antenna of the Würzburg radar device. (Photo: NARA)

At the same time as the *Kiel* , a whole family became significantly larger and for the Ground use provided heat direction finder developed, both for

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should serve to detect aircraft as well as ships. They were given the names *Heat Finder* (WPG) and *Night Measuring Device* (NMG), with the second device being intended as a complement to the first – it served as a three-dimensional image range finder. The whole system was the largest night vision system ever built during World War II. The diameter of the ellipsoidal mirror (WPG lens) was a full five feet (an ellipsoid is a body formed by rotating the ellipse around one of its axes, a paraboloid and hyperboloid are formed in a similar way, on the basis of which other mirror optics systems are made) .

With its long range, resulting from the large mirror collection area and high detector sensitivity, as well as the ability to measure target distance, the WPG/NMG system was the most complex attempt to create an alternative to radar. An alternative, mind you, that worked passively, making it much more difficult to detect by the enemy and difficult to disrupt. The most important system component - the *heat detector* - was developed by Elac and Zeiss at the same time , similar to the *Kiel III .* The possibilities of both variants were similar, although the Elac prototypes were characterized by a slightly longer range, after which work on the Zeiss model was stopped relatively early - probably as early as 1941, when the prototypes were being examined. The competition, on the other hand, received the first orders in 1943 - 1944, which meant the start of series production. At that time 90 WPG systems were ordered, all as ground variants for detecting ships. Only twelve were delivered by the end of the war, three of which could be installed in the bunkers on France's west coast before the Allies landed. Since only the optical system was located above the bunker roof, such a device, which rotated about its vertical axis and was slightly inclined horizontally, almost resembled a radar device from the outside, or rather a large anti-aircraft searchlight. The control system and most of the electronic devices were located a few meters below.

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Lfd. Nr.	Forschungsstelle:	Forschungsaufgabe:
1	Geheimrat Sommerfeld, München	Theoretische Bearbeitung physikalischer Probleme der F.T. (Ausbreitung und Akustik Schallfeld).
2	Prof. Harms, Würzburg	Spezielle Probleme der drahtlosen Peiltechnik, Peilverhinderung. Besondere Aufgaben der Rückstrahltechnik (Strahlun charakteristik, Erdbodeneigenschaft, Richtantennen für Extrem-Kurzwellen) Fu M.G.-Abwehr.
3	Prof. Ott, Würzburg	wie 2) und teilweise 1)
4	Prof. Joos, Jena Prof. Zahn } Göttingen Dr. Hellwege }	Absorption elektrischer Wellen (Fu M.G. - Abwehr)
5	Prof. Brückmann, Wien	Spezielle Geräteentwicklung und Untersuchungen über Phasenschieber (Anwendung für Rückstrahlgebiet).
6	Prof. Schumann, München	Röhrenentwicklung für ultrakurze und Dezimeter-Wellen. Spezielle Geräteentwicklung (z.B. Goniometer für F.T.Peilun
7	Prof. Karolus, Leipzig	Modulation von Quecksilberhöchstdrucklampen für Lichttelephonie. Bildwandler im langwelligen Infrarot.
8	Prof. Flüchtbauer, Bonn	Forschung auf dem Gebiet der Fotozellen in langwelligen Infrarot.
9	Prof. Zinke, Institut für Schwingungsforschung Berlin.	Breitbandantennen
10	Firma Siemens	Längstwellenkommandoübertragung für Torpedofernlenkung.
11	Kaiser-Wilhelm-Inst. für Metallforschung Forschungsanstalt Graf Zeppelin Inst.f.Nachrichtentechnik der T.H. Stuttgart	Magnetische Feldstärkemessung mit Hilfe hochfrequenztechnischer Methoden
12	Firma Gema Berlin	Klystron

- 2 -

Lfd. Nr.	Forschungsstelle:	Forschungsaufgabe:
	In eigenen Forschungsstellen der Kriegsmarine bearbeitete Forschungsaufgaben :	
13	Prof. Pungs, Braunschweig Leiter einer Arbeitsgruppe beim N V K	UK - und Dezimeter-Wellen-Technik. Untersuchungen der Peilungen kleinerer Höhenwinkel (Erdbodeneinfluss). Untersuchung von Breitbandantennen und elektrischen Kompensatoren.
14	Prof. Scherzer Darmstadt Leiter einer Arbeitsgruppe beim N V K	Durchführung spezieller Aufgaben der Rückstrahltechnik. Theoretische Arbeite über Breitbandantennen, Empfängerentwicklung, Empfangsmessgeräte.
15	N V K	Längstwellenkommandoübertragung für Torpedofernlenkung.
16	N V K	Ausbreitung von elektromagnetischen Wellen der Frequenzen 30 - 100 kHz.
17	Arbeitsgruppe Stuttgart der Entmagnetisierungsgruppe des O.K.M.	Magnetische Feldstärkemessung mit Hilfe hochfrequenztechnischer Methoden.
18	Marine-Observatorium Greifswald	Höhenwindmesser und Radiosonden
19	F E P III	Trichterantennen für Zentimeter-Wellen, Gruppenstrahler, Unterdrückung von Nebenwellen bei Trichterantennen. Möglichst scharfe Bündelung von Zentimeterwellen.

A German list of (selected) research projects in the field of radar devices, control technology, etc. (Photo: NARA / ALSOS)

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At least five other types of heat detectors based on semiconductor components were developed in the Third Reich, two of which can be shown to have been developed during the war and proved effective in practice. These were the *Würzburg B* and *Armin* models .

The first was a kind of "thermal imaging accessory" for the large airborne target detection radar, *Würzburg-Riese,* and was intended to be used in the event of severe interference with radar reception. The heat detector was installed on the tip of the paraboloid mirror of the radar device, which had a diameter of three meters. Despite the small lens diameter (25 cm mirror), the range was relatively large - the British "Lancasters" were tracked at a distance of 15-20 km. There were four detectors in the focal point of the mirror, which corresponded to four control lamps on the control panel. If all lights blinked evenly, the system was aimed squarely at the target. This device was probably constructed by the Berlin company GEMA, the same company that made radar devices. It was tested on the test site near Rechlin and near Kuehlungsborn.

Armin , on the other hand, was a heat finder developed by Elac for night bombers. It was intended to warn of approaching enemy fighter planes and featured a very complicated multi-lens system whose task was to ensure a large field of view (120°) and at the same time to scan it with sufficient accuracy , so that an approximate target silhouette could be recognized on the monitor (despite the use of a single detector). However, this was possible only if the target was no more than two kilometers away. Two versions of optical systems were tested in parallel and the heat detectors equipped with them were marked as *Armin I* and *Armin II .* The tests were completed in 1944, but series production did not take place.
One of the reasons for this was the likely very high cost of the optical elements. 82,90 Separately , some types of thermal bolometric imaging devices have been developed based on a different physical phenomenon: that the electrical resistance of some materials changes after they absorb infrared photons. None of these devices went into mass production, and most did not compete with heat detectors of the higher order

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of the type described. Among them, however, was a truly revolutionary system - revolutionary because it could already be called a (simple) thermal imaging camera. It did not show the "usual" spot on the monitor, but the full image of the objects in the field of view. Known as the *Potsdam-L* , the device was used for reconnaissance and was intended to be installed on aircraft to detect ground targets at night.

The device was based on a simple optical system and a scanner with a pivoting (oscillating) mirror that projected an infrared beam onto a special metal foil that acted as a photoresistor.
The current flowing through the foil then powered a lamp whose focused light was directed in the opposite direction of the infrared beam.
The light beam was reflected off the back of the mirror and projected onto a glass plate serving as a screen, which was coated with a thin layer of phosphor (and therefore glowed not only when the beam struck, but also for a short time afterwards). In this way, an image composed of lines was formed on the screen. This image ran at a speed proportional to the aircraft's airspeed. This effective, but not particularly complicated device was not constructed by a large corporation, but by a single person, a certain FE Leybold from Clansthal in the Harz Mountains. The US intelligence report on the *Potsdam-L* shows that, similar to other groundbreaking inventions, all prototypes were either destroyed or well hidden prior to the arrival of Allied troops. On the other hand, the operating instructions fell into the hands of the Americans, and they were also able to question a few witnesses. 82

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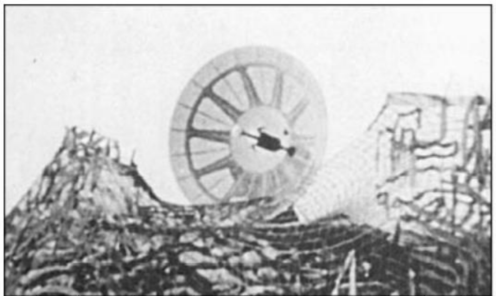
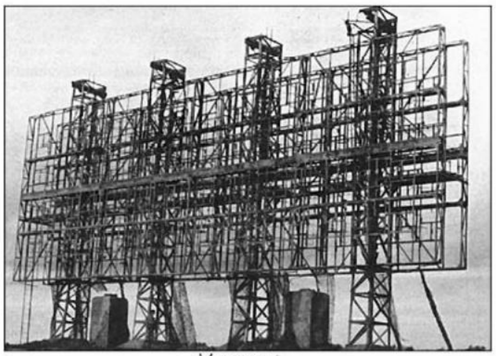
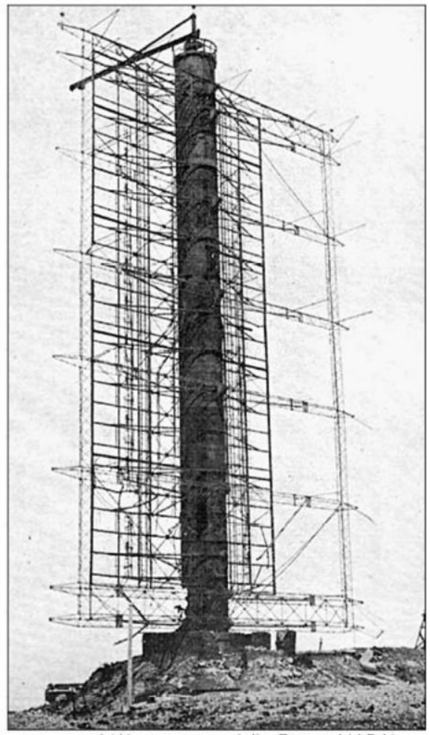


Einige deutsche Radargeräte mit großer Reichweite: *Würzburg …*



… Mammut …



… und *Wassermann*. (alle Fotos: NARA)

Despite the spectacular nature of the construction mentioned, it was not the only thermal imaging camera designed in the Third Reich. The American report indicates that there were at least two other models.

They were named *Eva* and *Fernaktinometer* (they were described as "thermal picture-forming devices"). Unfortunately, we only have detailed information for the first model. Since the description is very short, I'll give it as a whole: 90

> “The *Eva* device was built by Prof. Czerny from Frankfurt. It provides a rough thermal image of the object using interference colors created on a thin layer of liquid. The device was examined by the NVK. The observed image built up on the screen within three to eight seconds. The range was 200 to 300 meters.”

The thin layer of liquid was probably between two sheets of glass, as is the case with most interference filters. However, here the conjecture ends and the principle of operation of this invention remains unknown in reality. This puzzle is quite intriguing, in particular

if we consider that the camera probably had no moving parts while still providing a color image, which was in and of itself a startling achievement at the time.
We also don't know how the Germans planned to use this device, although it was certainly tempting to use it as a thermal sight for ground troops.

However, despite the scarcity of available data, one can still make a cautious assumption about *Eve* 's screen . It is difficult to imagine that the image was directly due to infrared absorption (because of the low power of radiation). However, we do know that Prof. Czerny was a pioneer in using bolometrics in this area - he studied materials that changed their resistance under these conditions. It is therefore possible that electric current flowed through the thin layer of liquid described: the resistance and thus also the temperature would change at the points that were illuminated at the respective moment. So the whole thing would work somewhat like an “amplifier” of the heat received. In this case, we would not only be dealing with a thermal imaging camera, but with a prototype color liquid crystal display (LCD) (a similar effect can be observed with simple patch thermometers that are stuck on the forehead: a very heat-sensitive liquid crystal layer changes color and " indicates" so that the corresponding number). The device descriptions above represent only a very modest summary. B. in semiconductor physics or in the development of new materials for the [illegible] elements. Recently, for example, B. in one of the documents of the Reich Research Council intercepted by the American "ALSOS Mission" to a reference to "light telephony" that worked in the infrared band. 85 Could this have been some kind of forerunner of today's fiber optic telephony?

aircraft carrier

I have decided to continue the overview of the new weapon concepts that were promoted in the Third Reich and are the subject of this chapter

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to add another, equally little-known subject area that will hopefully also arouse interest. It's about the plans to build German aircraft carriers.

On December 8, 1938, in the presence of Hitler, Goering, Admiral Raeder and countless other dignitaries, a large celebration took place in the "Deutsche Werft" in Kiel, which received great publicity from the German press. "The German Reich is reaching for naval supremacy," wrote the *Völkischer Beobachter that day.* The first aircraft carrier of the Kriegsmarine was launched, which was intended for use in the Baltic Sea and was characterized by a water displacement of 21,214 GRT. It was christened *Graf von Zeppelin* and was intended to represent the pinnacle of the technology of the time. It should - because at that time there was still a lot missing before its completion. However, everything indicates that it would indeed have been a very dangerous unit.
She was e.g. B. was equipped with the largest steam turbines to date, which enabled her to reach speeds of up to 34 knots.
Three years later, it was equipped with radar equipment, which was modern for the time, for detecting air and sea targets. Even the planned artillery armament was impressive: sixteen 150-mm guns with a range of 27 km, ten 105-mm guns, 22 large-caliber 38 automatic anti-aircraft machine guns. 86 After the victorious campaign in Poland, Hitler became 37mm anti-aircraft guns as personally interested in the fate of *Graf von Zeppelin ,* believing that he could play an important role in the planned invasion of Britain. At a staff conference convened in this matter, he ordered all work to be completed in record time and the ship to be put into active service by mid-March 1940.

However, this deadline was not met, mainly due to problems with the supply of large-caliber guns and many other devices. In addition, the issue of aircraft allocation was still unresolved. As it turned out only after the war, this was mainly the “merit” of Goering's intrigues. Luftwaffe Marshal Erich Milch remembered witnessing a conversation in 1940 in which Göring haughtily announced the following to the OKL chief of staff, General Jeschonek: 86

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> “Jeschonek, I'm telling you, Raeder will rather resign than create his own Luftwaffe under my nose. The Herr Admiral should know that only I in the Reich decide the fate of the Luftwaffe!"

Hitler found out about the dispute and on March 12 decided to end it by issuing specific orders to Goering. The Kriegsmarine was to receive 50 Bf-109F fighters, four Ju-87c Stuka dive bombers and thirteen Fi-167 Storch reconnaissance aircraft. These machines should be modified accordingly.

In addition, it was planned to build a twin unit *(Peter Strasser) .* The Kriegsmarine command also made the proposal to convert the passenger ships *Europa* (54,904 GRT), *Potsdam* (19,293 GRT), the former French unit *De Grasse* (20,396) and the heavy cruiser *Seydlitz* into aircraft carriers. However, all these plans failed, this time without any intervention from Goering. In the early days of 1943, the whole plan to expand (or rebuild) the fleet was re-evaluated, and the construction of submarines became a top priority. The unfinished *Graf von Zeppelin* was towed to Stettin, where it remained until the end of the war.

While this information is interesting, it is relatively well known and I would not have included it here if it did not set the stage for a much lesser known aspect of the whole story. A few years ago, while looking through the files of the Personal Staff of the Reichsfuhrer SS, I came across extensive correspondence and projects on blueprints for an alternative aircraft carrier fleet! [87]

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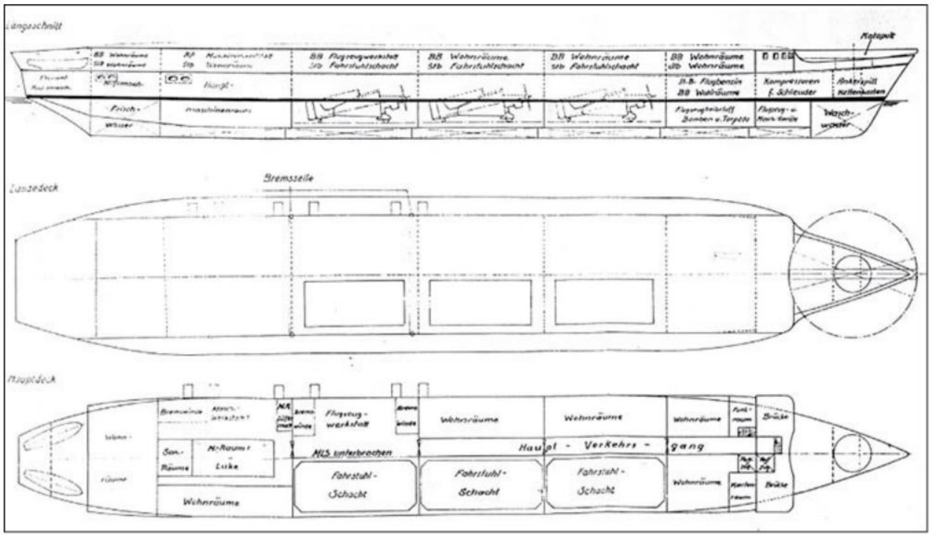

Original plans of the "small aircraft carrier". (Photo: AAN)

In this case, the initiative came from Dr. Heinrich Dräger, company owner and owner of the "Dräger" shipyard in Lübeck. His proposal is dated January 27, 1942. It is interesting in this connection that Dräger found unexpected supporters in Heinrich Himmler and the head of his personal staff, SS-Obergruppenfuhrer Karl Wolff. It was about the construction of an entire fleet of small aircraft carriers with a displacement of 3,500 tons, a length of 101.6 m, a width of 17 m and a draft of only four meters. The proposal aroused the interest of the SS and was widely discussed for almost two years, although Dräger planned to equip each unit with only six to seven aircraft!

The matter did not die of natural causes until the end of 1943, after a devastating verdict by the Navy, in which, among other things, the too short flight deck (90 m) was criticized. So, the KFT project *(small aircraft carrier)* had no meaning from a military point of view, but it clearly testified to Himmler's ambitions.

Unusual sources of energy

In the never-ending hunt for potentially disruptive technologies, much more unusual concepts than those previously mentioned have begun to be tested. Many such examples - alleged as well as real

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– can be found in the comprehensive topic complex “new energy sources”. In the book by Prof. Mark Walker, a historian who has analyzed German work in the field of nuclear physics, we find e.g. B. the the following description (page 91 of the 1999 edition): [91]

> “Many participants in the nuclear energy project were tasked with the irrational search for silver bullets. Werner Heisenberg and other top German physicists were required to judge proposals for inventions. Although Heisenberg was besieged by inventors throughout his life, such emotionally charged contacts with amateur scientists became increasingly dangerous during this phase of the war.
>
> As the war situation deteriorated, the Nazi leadership took an ever greater interest in the creative potential of every German, especially the soldier serving at the front.”

Then follow some examples of pointless inventions. We read further:

> “In at least one case, however, Heisenberg did not get rid of an inventor so easily. In July 1943, the Ministry of Armaments and War Production asked Heisenberg to evaluate the invention of an engine that would work without any fuel. The Ministry admitted that this would be tantamount to the existence of a perpetual motion machine, but independently insisted that Heisenberg analyze this proposal, which had been submitted by an engineer named Günther. Heisenberg responded two days later that the author's claim of being able to create energy from nothing was untenable, adding that the proposal was written so incoherently that he had difficulty reading it through to the end. A few months later, the Ministry was heard from again. Günther was so disappointed by Heisenberg's skeptical attitude that he appealed directly to Hitler.
>
> The ministry spokesman asked Heisenberg to reconsider the matter. He was even asked to arrange a meeting with Günther.” There were many such examples. Even if most of them are pure

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were a waste of time, we cannot ignore this phenomenon when analyzing technical progress in the Third Reich - for the simple reason that it sheds light on the mechanisms of this progress.

Der Reichsgeschäftsführer

Berl...
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Schriftgutverwaltung
Akt.Nr. Geh./ 218

Geheim

An
Reichsführer-SS
Persönlicher Stab
Berlin SW 11

Prinz Albrecht-Str. 8

7.2.43
28

Betr.: Angelegenheit Karl Schapeller, Aurolzmünster
Bezug: Dort.Schr.v.16.9.42 AR 22/39/42
Anl.: 1 Vorgang

Als Anlage gebe ich den mir von dort übermittelten Vorgang zurück. Über die zur Untersuchung heranzuziehenden Professoren wurde mit dem Reichssicherheitshauptamt Übereinstimmung erzielt. Zur Verfügung gestellt haben sich:

1.) Prof.Dr. Bothe, Heidelberg,
2.) Staatsrat Prof.Dr. Esau, Berlin.

Auf Vorschlag von Staatsrat Prof. Dr. Esau wird zunächst Prof. Dr. Bothe sich mit der Angelegenheit befassen, er wird noch im Januar zur Rücksprache nach Berlin kommen. Die Angelegenheit wird in Fühlungnahme mit uns weiter bearbeitet.

SS-Standartenführer

Pers. Stab RF-SS	Anlagen
Eingang am: 11. JAN.1943	
Tgb. Nr.: 22/15/43	
an: RF	

Selected documents from the files of the Personal Staff of the Reichsfuhrer SS that describe the work of Karl Schappeller. (See also following pages)

In the files of the Personal Staff of the Reichsfuhrer SS I came across a classic example of such charlatanism. An entire folder is dedicated to a certain Karl Schappeller, who claimed that he could extract unlimited amounts of energy from ordinary water. The source of this energy should be some unspecified nuclear reaction. Of course, the documentation includes a device description, but this is so unclear that it is impossible to find out what it is actually about. An extract from this documentation can be found on the following pages. Crucially, while such ideas were incompatible with common sense, they were not dismissed outright. The supposed discoveries of Schappeller were evaluated by Prof. Abraham Esau, who wrote the following: 92

“A material or ideological support for Schappeller would be

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irresponsible – he has a pathological personality, his ideas are completely confused and pure imagination."

Sometimes, however, it turned out that not discarding ideas that appeared to be imaginary proved to be worthwhile, since the benefit of realizing authentic novelty outweighed the eventual costs of impostor cases , totally outweighed.

An example of this is the inventions of Hans Coler, which most likely represented an authentic and groundbreaking discovery. They were not only investigated in the Third Reich during the war, but also after the war by the British intelligence service.

When originated The result is a comprehensive intelligence report that documents this discovery and confirms its authentic character.

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A b s c h r i f t

Bericht über das Vorhaben Schappeller

Die Unterredungen mit Schappeller Vater und Adoptivsohn im Schloß Aurolzmünster und die eingehende Besichtigung des Schlosses am 11.1.43 ergaben folgendes:

1. Natur des Projektes. Sch. Vater hat eine angeborene Neigung zu naturphilosophischen Betrachtungen. Jedoch mangelt es ihm an Denkdisziplin, und seine Kenntnis physikalischer Tatsachen beschränkt sich auf einige allereinfachste Schulexperimente. Daher haben seine Überlegungen lediglich den Charakter verschwommener und unfruchtbarer Spekulationen über Vakuum, Feuer, Magnetismus u.ä.

Von diesen Spekulationen ausgehend, behauptet Sch. Vater, ein neues Verfahren zur Energiegewinnung gefunden zu haben. Die technische Ausarbeitung dieses Verfahrens hat er seinem Adoptivsohn übertragen, der früher bei einigen elektrotechnischen Firmen tätig war. Nach diesem Verfahren sollen unbegrenzte Energiemengen aus der Atomenergie gewöhnlichen Wassers entnommen werden können. Hierfür ist eine Apparatur geplant, die nach längerem Widerstreben folgendermaßen beschrieben wurde. Eine Hohlkugel aus Eisen ist auf der Innenwand mit zwei halbkugelförmigen Wicklungen aus hohlem Kupferdraht ausgekleidet. In den Polen der Wicklungen trägt die Hohlkugel innen zwei Eisenzapfen ("Magnetpole"), mit denen je ein Ende der Wicklungen verbunden ist. An die freien Enden der beiden Wicklungen soll der zu betreibende Elektromotor angeschlossen werden. Die hohlen Wicklungsdrähte sollen mit einer geheimnisvollen Substanz gefüllt werden, die einmal als "Oel", dann wieder als "Elektrolyt" bezeichnet wurde; auch sollen noch besondere Stoffe beigemischt werden, und das ganze soll in nicht näher beschriebener Weise präpariert werden. Der verbleibende Raum in der Eisenkugel soll mit einer besonderen Asche ausgefüllt werden. Bevor jedoch dieser Apparat arbeiten könnte, müßte er "geladen" oder "gezündet" werden, indem man ihn für eine gewisse Zeit mit den beiden "Magnetpolen" an eine starke Dynamomaschine anschließt. Die Energieerzeugung selbst soll dann so vor sich

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gehen, daß man den einen "Magnetpol" über ein "Element" mit einem Wasserbehälter, dem Meerwasser o.dgl. verbindet. Das "Element" soll jedoch kein gewöhnliches galvanisches sein, es soll z.B. drei Elektroden enthalten. Die Energie soll durch Zersetzung des Wassers frei werden, jedoch wiederum nicht durch gewöhnliche elektrolytische, sondern eine besondere Art von Zersetzung. Die Energie soll "in Form von Elektronen" durch den Apparat "angesaugt"werden.

Die so erzeugte Energie soll von einer grundsätzlichen neuen Art sein, sie wurde u.a. als "komprimiertes Feuer", "geballtes Vakuum", "glühender Magnetismus", "freier Magnetismus", Solenoidkraft" bezeichnet, der Vorgang der Energieerzeugung als " Zerlegung des elektrischen Stromes".

Das ganze kann nur als barer Unsinn bezeichnet werden. Irgend ein gesunder physikalischer Gedanke steckt nicht dahinter.

2. Bisherige Vorbereitungen. Irgend welche Experimente sind zugegebenermaßen bisher nicht ausgeführt worden. An apparativer Ausstattung fanden sich bei der Besichtigung des Schlosses nur je ein alter Strom- und Spannungsmesser billigster Type, sowie etwas einfaches Werkzeug und Material für Lichtinstallation. Einige weitere Gegenstände sind angeblich dem Konkurs zum Opfer gefallen. Eine Laboratoriumseinrichtung hat jedoch offensichtlich nie bestanden, obwohl seit 1928 gegen 700 000 RM verbraucht wurden. Nach der Beschreibung der "Maschine" hätte es möglich sein sollen, für einen kleinen Bruchteil dieser Summe die nötigsten Einrichtungen für einen Versuchsbetrieb zu beschaffen. Daß dies nicht geschah, wird von den Sch. damit entschuldigt, daß angeblich die Verwendung dieser Gelder (für die Instandsetzung des Schlosses u.ä.) durch die Geldgeber vorgeschrieben war.

Konstruktionszeichnungen der "Maschine" sind ebenfalls nicht vorhanden. Angeblich haben sie existiert, sind aber aus Anlaß einer politischen Verfolgung schon in der Zeit vor dem Anschluß der Ostmark verbrannt worden. Neue Konstruktionspläne wurden inzwischen nicht angefertigt.

3. Ziele. Sch. Vater gibt an, mit seinen Bestrebungen

The report is entitled: "An invention by Hans Coler connected to a supposed new source of energy". This report can currently be found in British and American archives (although it is claimed that it is only part of it - the original was said to be over 150 pages longer and also described use as a propulsion system for various weapon systems). Although the spelling "Hans Coler" predominates in the title and in the document itself, find

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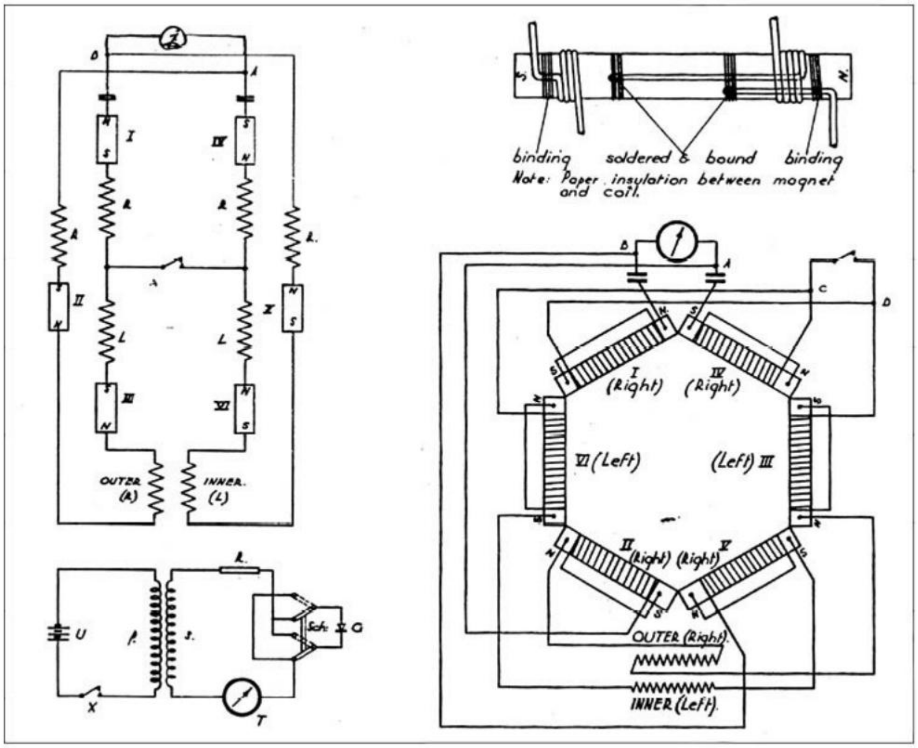
Elsewhere, the German spelling "Kohler" (which sounds more believable). However, I will stick to the spelling as it appears in the relevant documents.



Schematics from the BIOS report on Coler's invention.

In the first chapter of the report we read the following introduction:

"Coler is the inventor of two devices that make it possible to generate electrical energy without a chemical or mechanical source. Since the German Admiralty [it is obviously about the High Command of the Navy – OKM; Note d.
Authors] officially showed an interest, it was assumed that it might prove worthwhile investigating [the devices], when otherwise it would have been determined that it could only be fraud.

So Coler was paid a visit and interrogated. It turned out that he was willing to cooperate and was willing to disclose all the details of his devices. He agreed to make a small model [of the invention] called 'Magnetstromapparat'

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to be constructed and commissioned from the materials provided by us, working solely in our presence. With this device, which consisted entirely of [emphasis added] permanent magnets, copper windings and capacitors (hardly connected together), he was able to generate a voltage of 450 millivolts [0.45 V] for several hours. The next day, when the experiment was repeated, 60 millivolts were measured for a short time.

The device was brought in and will be further examined.

Coler also talked about another device called a 'power generator' which, using a few watts of power from a dry cell battery, could provide 6 kilowatts of power indefinitely. Not a single example of this device currently exists, but Coler agreed to build it from the materials provided, which would take him about three weeks.

The opportunity was taken for Dr. F. Modersohn, who accompanied Coler for ten years and financed his work. He confirmed Coler's story in great detail. However, none of them was able to come up with even a theory that could explain the workings of these devices in accordance with generally accepted scientific views."

Another part of the report contains a summary of the most important technical characteristics of both devices (precise descriptions including technical drawings are printed in the appendix). This information forms the background to the history of both inventions. Here is their translation: 1. The "Magnetstromapparat" The device consists of six permanent magnets

which are connected to one another in a special way, in such a way that the electric circuit includes both the magnets themselves and the winding. As can be seen from the diagram, these six magnets (coils) are arranged in the shape of a hexagon and make up the part of the circuit that includes two small capacitors, a switch and two selenoid coils, one coil slipped inside the other. In order to put the device into operation, the

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Circuit broken by the switch, the magnets pushed apart slightly and the adjustable coil set to various positions, allowing a few minutes between each setting. The magnets are then pushed further apart and the coils adjusted again.

This process is repeated until the voltmeter reads that the magnets have reached a critical distance. Now the switch is closed and the process continues at a slower pace. After that, the electrical voltage gradually reaches the maximum value and should be maintained indefinitely. According to the explanations, the highest voltage reached was 12 V. The "Magnetstromapparat" was developed by Coler and von Unruh (who died) as early as 1933. Franz Haid from the Siemens-Schukert company later joined the research and built a working model himself in December 1933. This device was developed by Dr. Kurt Mie from the Technical University in Berlin and Mr. Fehr (Haber's assistant at the KWI) assessed. He concluded that the device worked and that they were unable to detect any tampering. A 1933 model locked in a room at the Norwegian embassy in Berlin was found to function for three months. Since then, no further research has been done on the device. [really??? – note d. author]

2. The "Power

Generator" This device is composed of suitably interconnected magnets, flat coils and copper plates, with the primary circuit being powered by a small dry cell battery. The output of the secondary circuit was used to supply a lamp set. According to the explanations, the electricity generated clearly exceeded the power consumption and was available indefinitely.
Details of this circuit and a theory of operation have been given (summarized in Appendix I). In 1925 Coler Prof. Kloss from Berlin demonstrated a small 10 watt version of the device. Kloss approached the government with a request for an in-depth investigation, but it was granted

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- similar to the patent application - rejected on the grounds that it would be a "perpetuum mobile". Professors Schumann (Munich), Bragstad (Trondheim) and Knudsen (Copenhagen) also saw this device version. Kloss and Schumann's reports have been translated in Appendices II and III. In 1933, Coler and von Unruh built a slightly larger model that delivered 70 watts of power. It became Dr. F. Modersohn, who received confirmation of their 1926 experiments from Schumann and Kloss. Eventually Modersohn came to the conclusion that this invention should be supported and formed a company (Coler GmbH) to continue the research and development work. At the same time, Coler was receiving financial support from a Norwegian group, which led to a dispute between the two groups. Due to his connections to the company Rheinmetall-Borsig and his contacts to Hermann Göring [actually to the group Hermann Göring Werke (renamed Salzgitter after the war) – editor's note. Authors], however, Modersohn gained the upper hand. Later (1937) Coler built a larger version for the company, capable of delivering six kilowatts of power. In 1943 Modersohn was able to interest the research department of the Naval High Command (OKM) in the device. Chief building officer Seysen was commissioned with the research management, Dr. H.

Cheerfully delegated to work with Coler (April 1, 1943 to September 25, 1943). Fröhlich was convinced of the reality of the [investigated] phenomenon and began researching the basic functional principle of the device. There is much to indicate that he concentrated on studying the energetic conversion processes that occurred when the induction circuits opened and closed. At the end of this time he was transferred to BMW, where he took on the task of solving aerodynamic problems. He is currently working in Moscow.

In 1944, the OKM signed a contract with the company Continental Metall AG for the realization of further research and development work, which, however, was not carried out due to the general state in which the country was. 1945 became

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the device was destroyed by a bomb in Koÿobrzeg (Kolberg), Coler was evacuated. Since that time, Coler has worked as an engineer and as a laborer. Modersohn strengthened his connection to the Rheinmetall-Borsig company. He became its director and worked for the Russian authorities as a technical adviser in the field of chemical engineering.

In addition, in the further part of the British report at the Coler's summary of the interrogation transcript states that, in his opinion, the magnetic field strength emitted by the magnets did not drop as the device was operated. In other words, there was no "consumption". Coler claimed that it was a new, previously unknown type of energy which he aptly named "space energy".

However, the most interesting part of the British intelligence report is undoubtedly the description of the investigation they carried out into a copy of the generator already being built in Britain. The device had no casing so there could be no doubt that no power source was hidden inside. The British also took great care to rule out the possibility that the generator was actually drawing energy from external, artificial electromagnetic fields due to induction (e.g. from the surrounding wiring). It was therefore placed far away from all current-carrying lines, so that the remaining fields were not sufficient for induction - it was sufficient to carry out simple calculations. Despite this, the generator worked perfectly. For the British, this result was "inexplicable".

In the Conclusions section we read the following:

1. It can be assumed that Coler was not a fraud but an honest experimenter, therefore Fröhlich's assessment of the report for Seysen in this matter should be viewed with due respect.

2. The result achieved corresponded to reality insofar as it could be verified with the installations available, but no attempt was made to explain this phenomenon.

3. It is assumed that further investigations will be carried out by an expert in the field of electromagnetism theory

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should be made, and that Coler's offer to build a "power generator" should be accepted.

Shocking?

The issue of Coler's inventions is an interesting and important example of the realization of a concept despite being inconsistent with the scientific theories of the time - something that seems almost unthinkable today. It should not go unmentioned that incompatibility with the knowledge of the time does not mean incompatibility with the present state of affairs. A number of discoveries in recent years suggest that Coler's case may have involved exploiting the so-called quantum fluctuation of the space-time continuum. This represents the source of the so-called zero-point energy. Here is an excerpt from a modern popular scientific article on this topic: 94

> "The existence of a non-zero cosmological constant [the 'cosmological constant' is a parameter used in physics to denote the magnitude of the zero-point energy—ed. Author's], can be interpreted as the presence of an equally homogeneous medium, which, although invisible, collects within itself a certain amount of matter or its equivalent energy. This energy is also called 'zero point energy'. Quantum field theories state that the zero-point energy can be either zero or very large.
> Since in this second case the cosmological constant would have to assume a value many times over all observed constraints, it seems most reasonable to assume that it is equal to zero. […] However, the most recent observed data says otherwise." They say something else **entirely** As our press reported in late 1999 (just after Britain's

monthly journal *Nature)* zero-point energy represents a whopping 70% of all the energy in the universe! It turns out, then, that we are surrounded by an unimaginably vast sea of energy that few knew existed, [95] and contrary to school knowledge that was prevalent just a few decades ago, this sea is the dominant energy in nature. It is therefore difficult to

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to dodge an almost rhetorical question: could the discovery of the method of drawing from this infinite sea of energy be considered a millennium breakthrough?

Work in this area is currently ongoing in various countries.

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In the second part you can read:

Weapons that could have changed the course of the war

THE RAPID DEVELOPMENT OF GUIDED WEAPONS

The fire lily

The Waterfall (C-2)

The Typhoon

The Henschel Hs-117 (Butterfly)

The Rhine daughter

The adder

Air-to-Air Missiles

Air-to-surface and surface-to-surface missiles

Guided Bombs

Target seekers for heat sources

STEAM JET FIGHTERS

BIOLOGICAL WEAPONS

CHEMICAL WEAPONS

NUCLEAR

GERMAN PROJECTS CONSIDERING THE AMERICAN

TECHNOLOGY DRAINAGE (OPERATIONS ***PAPERCLIP*** AND ***lusty)***

Decisive for the war: The ultra-secret project “Die Bell jar"

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CIOS = Combined Intelligence Objectives Sub-Committee common message goals) pursued the same goals

NAIC = National Air Intelligence Center, collects and evaluates information about enemy missile systems 1

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One of the numerous German responses to the Soviet Katyusha project. (Photo: ALSOS)

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table of contents

The concept of retaliatory weapons

- The V1
- The V2
- The V3
- The Rhine Boat
- Other Vengeance Weapons

The Luftwaffe A time of search

- The Me-262
- The Me-163
- The He-162
- The Ho IX
- Messerschmitt P-1101
- Focke-Wulf Ta-183
- jet bomber

Electromagnetic weapons and alternative solutions

The unknown face of armored vehicles

Conventional weapons: entirely new concepts

- energy emitter
- "Invisible" planes and ships
- plastics
- The war under water
- Concrete Ships
- Recoilless Weapons
- Unusual Ideas
- New generation handguns
- infrared technology
- aircraft carrier
- Unusual sources of energy
- In the second part you can read:

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Weapons that could have changed the course of the war
Decisive of the war: The ultra-secret project "The Bell"
bibliography